Materials & Methods

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Metal Show Preview

General Purpose High Temperature Alloys

Pressed and Sintered Nylon Powder Parts

Thin Carbide Coatings by New Surfacing Methods

Two New Synthetic Rubbers

Lead-Clad Steel and Copper

New Developments in Adhesives

Comparative Specifications for Alloy Steels

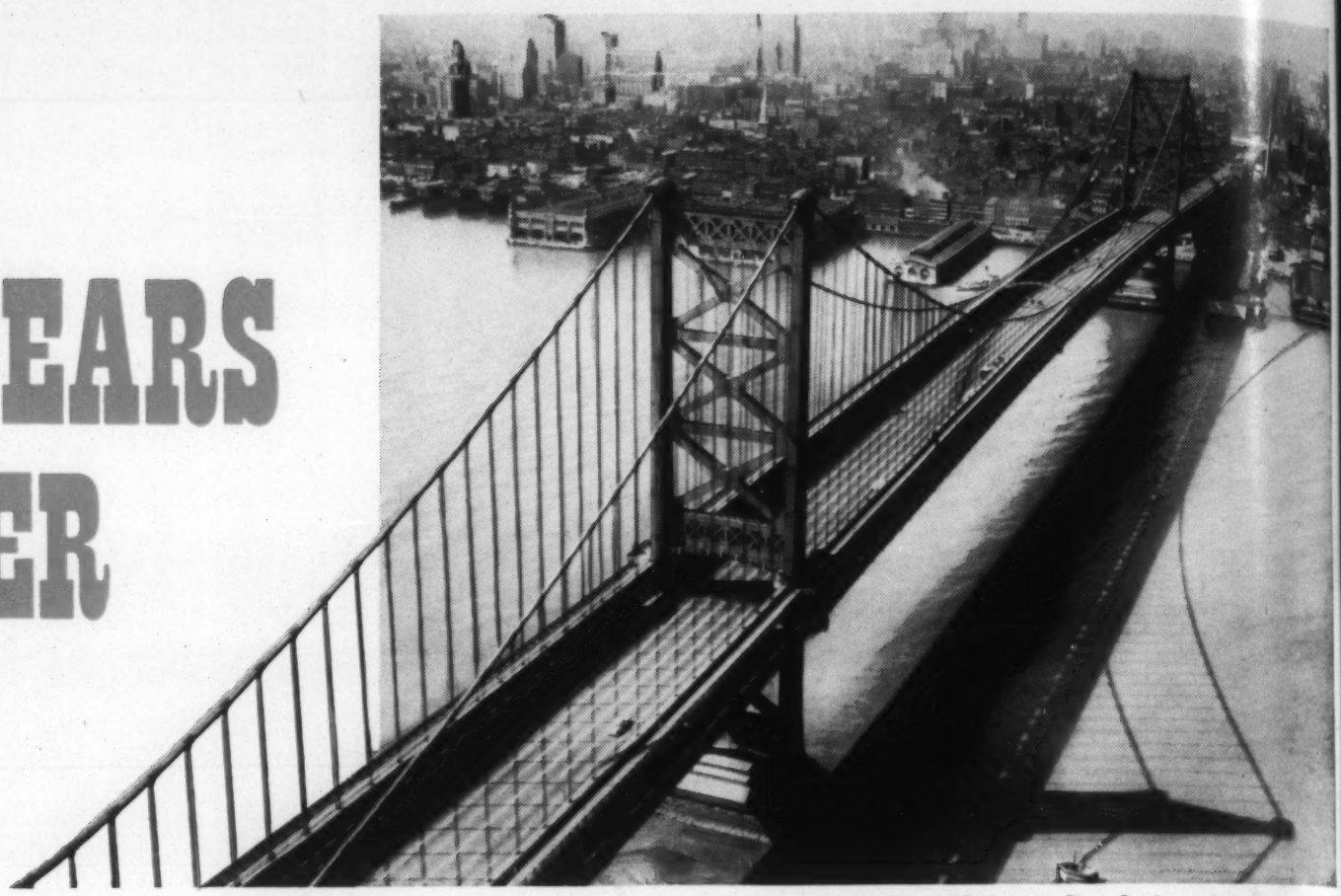
New Methods for Shaping Difficult-to-Machine Materials

CARBURIZING OF STEELS
—Materials & Methods Manual No. 87

OCTOBER
1952

THE MAGAZINE OF
MATERIALS ENGINEERING
DEVOTED TO THE MATERIALS PROBLEMS OF PRODUCT DESIGN AND MANUFACTURE

15 YEARS LATER



Aerial view of Delaware River Bridge taken in the spring of 1952, showing the High Speed Rail Transit Lines on outer sides of bridge. Photo by Aero Service Corporation.

...a report on the service of Everdur Electrical Conduit on the Delaware River Bridge

The Delaware River Bridge, linking Camden, N. J. with Philadelphia, opened to vehicular traffic in July 1926. In 1934-36, when the High Speed Rail Transit Line was installed, more than 200,000 pounds, or 14½ miles of Everdur* Conduit, in nominal sizes from 1½" to 4", was used for electrification and electro-pneumatic signal operations.

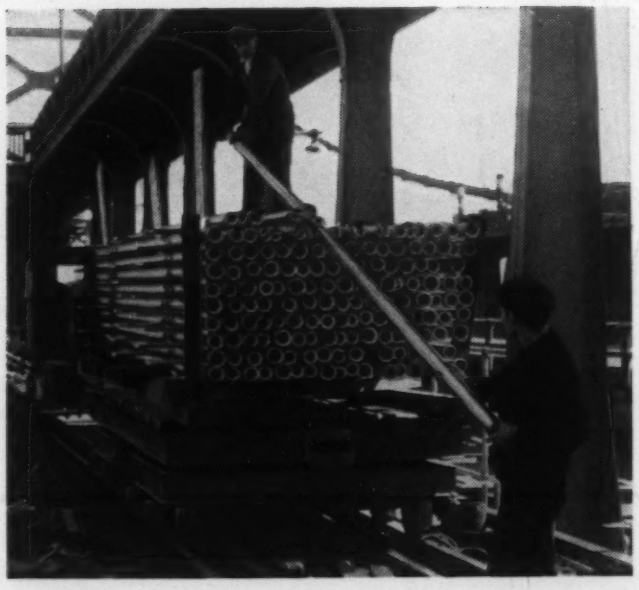
Service conditions were anything but good—and the problems encountered included corrosive industrial gases and almost continual vibration caused by the rapid transit rail cars and 70,000 motor vehicles a day.

Now, with another bridge expansion project planned, an engineer of The American Brass Company made an "on-location" inspection of the 15-year-old installation. The detailed report concludes as follows:

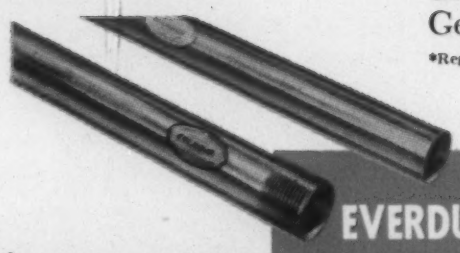
> *"It is my opinion that the corrosion rate of the unpainted Everdur Conduit installed on the Delaware River Bridge is very low, and that the conduit will last as long as the bridge itself."*

Everdur Electrical Conduit is made of Everdur Copper-Silicon Alloy in two wall thicknesses (R.C. and E.M.T.). Publication E-12 describes this ANACONDA Product in detail. For a copy, address The American Brass Company, General Offices, Waterbury 20, Connecticut. 52168

*Reg. U.S. Pat. Off.



In 1936, at the time of installation, the Transit Line rails were utilized to transport 20-foot lengths of Everdur Conduit to the cable runways.



wherever corrosion resistance counts ***consider***

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THE MAGAZINE OF MATERIALS ENGINEERING • VOL. 36, NO. 4 • OCTOBER, 1952

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The age of push-button steelmaking has not yet arrived. But many a steel buyer has learned that a buzz to his secretary is the first step in making contact with a team of steel experts who can put their special knowledge and skills to work making the *right* steel to do the job. We have this team at Inland.

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The Materials Outlook

Commercial steel specifications will be used by the Navy where they parallel Navy specifications. New program was started by the Office of Navy material. Increased availability of steel for the Navy, as well as time and effort savings for producers, are expected.

Flame plating coats metal parts with a very thin layer of extremely hard materials. Tungsten carbide is deposited without being diluted by the base metal or welding rod. Coating is unusually ductile. Other high melting materials can also be applied. (See page 112)

Layer of special rubber seals the inside of an aircraft tubeless tire now being tested. Ridges molded on the outside of the tire seal the rim. Tires give safer high-speed takeoffs and landings, reduce weight, and simplify assembly.

High temperature lubricants permit operation of electric motors at 300 F, with relubrication at 500- to 1000-hr intervals. Motor design changes will greatly lengthen relubrication interval. Silicone-lithium soap greases are good for 6000 hr. At 100 F, these greases stand up for 10,000 to 15,000 hr.

Improved supply of zinc is not temporary, American Zinc Institute assures users. The metal is no longer scarce and no regular purchases are being made for national stockpile. Substitutions which result in imperfect products are no longer necessary, warns the Institute.

Oil-impregnated sintered metal bushings are used on special roller chain. Whitney Chain claims longer service life where normal forms of lubrication are not available or desirable.

New ferromagnetic alloy with temperature coefficient of elastic modulus that can be controlled over a wide range has been developed. High strength is another property. One application is in vibrating reed selectors. The modulus change can be designed to keep response frequency constant despite temperature changes. Vibralloy is the name.

New high temperature alloy has practical applications up to 2200 F. Higher loading above 2000 F and less oxidation are the improvements given.

Backing of glass-reinforced strapping tape strengthens abrasive belts.

(Continued on page 4)

The Materials Outlook *(continued)*

The belt joint is also reinforced and the crosswise rigidity of narrow belts is increased.

Glass-reinforced polyester bathtub will be announced commercially in the next few weeks.

Corrosion causes most wear in automobile cylinders, according to International Nickel Co., Inc., researchers. At operating temperatures below dew point of combusion products, agents like carbonic, sulfuric, organic and halogen acids cause damage. Higher operating temperatures (190 F), better oil supply to cylinder walls, neutralizer and inhibitors agents to make oil cling to walls and corrosion resisting alloys are recommended.

Plastic battery separator is designed to replace wood items. Manufacturers claim plastic is tougher, more durable, porous, heat resistant and uniform in quality. Improved capillary action brings moisture to top when water runs low. Acid also circulates faster because of porosity.

Thin stainless steel is butt welded by new technique. Naval Ordnance Laboratory developed method. Electricity from capacitors is discharged into welds through transformers in 0.010-sec periods. T and I beams with 0.135-in. wide, 0.0083-in. thick flanges and 0.25-in. wide, 0.0077-in. thick webs can be welded.

Honey-comb-like plastic was developed by an aircraft company to add strength to delta wings. The syrupy liquid is poured into the wing, where it is foamed up to press solidly against the metal, then hardened. Densities range from 1½ to 35 lb per cu ft. New applications are expected in potting equipment, filling doors and fuselage sections and in guided missile skins. . . . The flexible form of this plastic differs from cellular rubber in one way. A weight dropped on the plastic does not bounce. It stops, then rises slowly. The action is like a mechanical shock absorber.

Porcelain enameled aluminum has been authorized by the Navy for limited use for bulkheads in certain vessels undergoing conversions. Further use depends on flame barrier and ballistic property tests. It is not thought that enameled aluminum will supplant enameled steel, however. Both have their merits, according to Navy experts.

Luminescent porcelain enamels emit light of various colors when excited by ultra violet light. Some give off light only during excitation (fluorescent). Others continue to glow after excitation stops (phosphorescent). Selling features over other luminescent mediums include high abrasion resistance, chemical durability, weather resistance and easy cleaning.

See page 6 for "Materials Control Orders"

Republic Steel Now Producing Titanium

Third largest steel company buys sponge, supplies ingot sheet, plate, strip, bar and wire forms of titanium to aircraft and defense industries. Major production is commercially pure titanium. Chromium-iron and manganese alloys are being developed.

Republic Steel Corp. has announced that it is producing titanium and titanium alloys at its Canton and Massillon, Ohio, steel plants. Republic, the nation's third largest steelmaker, is the largest steel company to announce that it is working on the new metals.

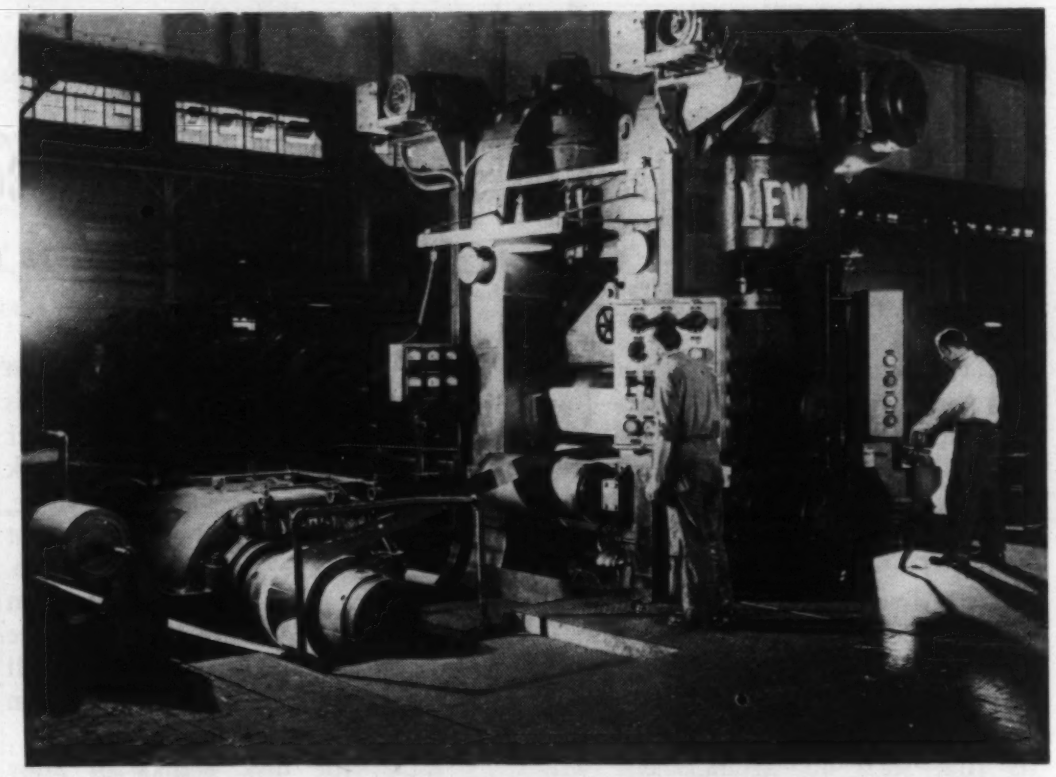
The processing and rolling of titanium and titanium alloys, aside from melting, is similar to that of alloy and stainless steels. Thus, it is expected Republic's large team of research, metallurgical and production personnel may be expected to contribute to the development and production of the new metals in commercial quantities.

Republic says it has been supplying titanium and titanium alloys in ingot, sheet, plate, strip, bar and wire forms for the last two years for aircraft and other defense programs. Production is still limited and is under strict allocation by the government.

A spongy form of titanium which is 99.5% pure is produced by chemical processes. Republic is now buying the titanium sponge, having no plans at present for making the product. This raw material is then melted in special furnaces and the ingots forged or rolled into various forms.

Titanium is melted by Republic at its South Division plant in Canton, Ohio, by both the arc and induction methods. The company has several small furnaces in experimental production, and is planning to install additional equipment for both melting and processing.

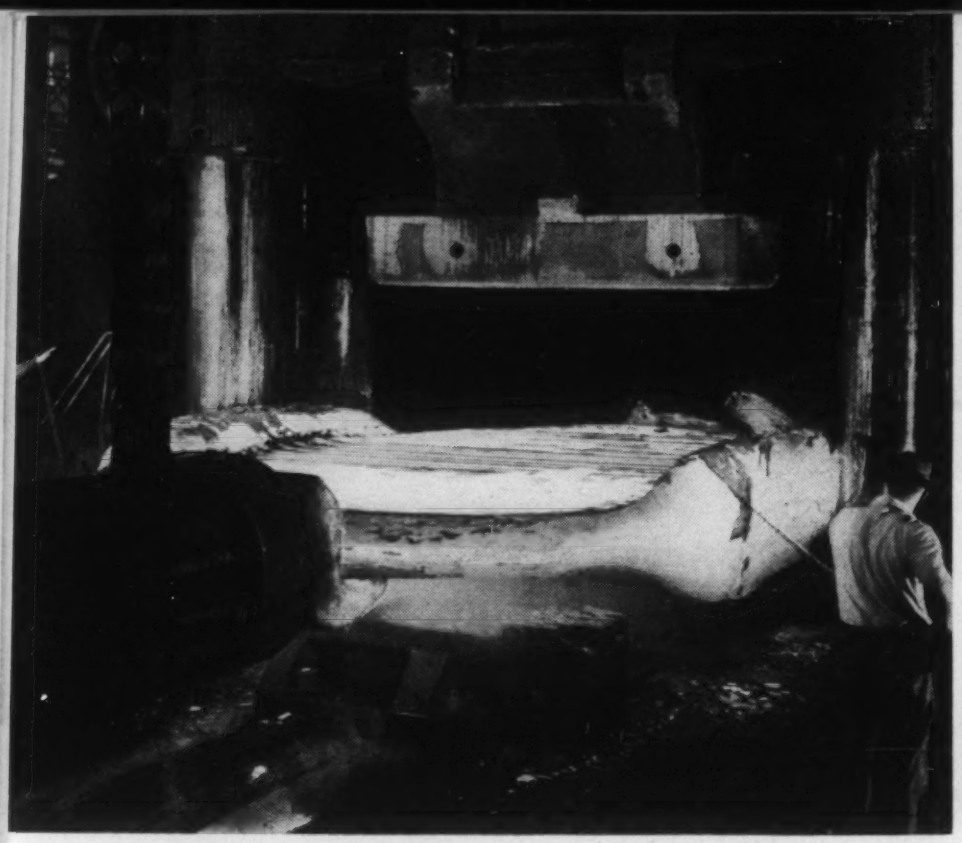
Induction melting is carried out in a very dense grade of graphite under an atmosphere of inert-gas —either argon or helium. In arc melting, specially prepared sponge is fed continuously into a water cooled copper crucible under an inert gas atmosphere and melted with a direct current graphite, tungsten or other type electrode. Of the two methods of melting, indications are that the arc-melted product would find most widespread application.



Mills similar to this one will be used in the production of titanium sheet at Republic Steel.

Alloy content of titanium alloys probably will not exceed 15%, with most high strength grades running between 4 and 10%. Included among the alloys are iron, chromium, manganese, aluminum, and many others. Major production is confined to the commercially pure product, but Republic is doing considerable development work on the chromium-iron and manganese alloys. Other alloys can be modified to give variations in properties so that a fairly wide range of physical properties is possible.

All of the common machining operations can be performed on titanium. Commercially pure titanium can be spot welded, seam welded or inert-gas welded to itself. Welding of alloy grades by conventional methods has not been too successful, but indications are that hot pressure or flash welding may prove satisfactory. Titanium has been successfully brazed to itself and to other metals.



Forging operation finishes the greater part of the piece to the required thickness in a lengthwise path. Limited by the spread of the press columns, the entire piece cannot be forged to required thickness during this operation, leaving lips on each side.

The 18-ft diameter forging did not permit conventional transportation from shop to shop. Held at an angle, disk was moved through doorway on railroad well car especially rigged for the job.

Large Disks Forged for Wind Tunnel Compressors

48-Ton Ingots Are Forged into Disks 18 Ft in Dia.

The greatest power output ever harnessed to a single shaft—four electric motors totaling 180,000 h.p. —will be required to operate the new supersonic wind tunnel at the NACA's Ames Aeronautical Laboratory. The drive system will be so arranged that it can be connected to either of two very large compressors, each of which will be used independently to operate the tunnel. The reason for the two compressors is that such an arrangement will permit its use over a broader speed range.

Construction of the two axial-flow compressors, which look like a giant tube 50 ft long and 24 ft in dia studded with small blades, is being carried on by the Newport News Shipbuilding and Dry Dock Co. of Virginia. The larger of these, with 11 stages, will weigh about 1300 tons. The Newport News Co. also is constructing two diversion valves for the tunnel. These are similar to huge valves, and they will be used to divert the air flow from one channel to another.

When the disk blanks of alloy steel for the larger of the two compressors were forged by the Bethlehem Steel Co., for shipment to Newport News for final machining, numerous special problems arose. The Bethlehem people started with a 92-in. ingot, weighing more than 48 tons. Due to the diameter of the forging and to the limited distance between press columns, position of the forging under the 7500-ton press required partial forging of two disks at the same time to avoid unequal loading of the press.

The Bethlehem Co., in discussing its part in this important project, said the rotor disks were wider and heavier than the pole pieces that were forged at its plants for the Columbia University and University of Chicago cyclotrons.

Building Machine Makers Save Nickel, Molybdenum, Copper

Research by the construction machinery industry in finding and using substitutes for nickel, molybdenum and copper is stretching the nation's critical supply of these scarce metals, the National Production Authority has announced.

The International Harvester Co., for example, reports savings of 79% in nickel and 72% in molybdenum by switching from nickel and molybdenum alloys to the relatively new chromium-boron steels for certain parts of their crawler-tractors and trucks.

Savings of more than 11 lb of nickel in each D8 Caterpillar tractor has been accomplished principally by switching from nickel alloy steel to induction-hardened plain carbon steels. The company estimates that the total nickel savings over the past ten years is very close to 12,000 tons.

Allis-Chalmers has cut the copper and brass used in water and oil radiators by 27%. This has been done by reducing the thickness of tanks and headers by 1 gage; by reducing fin stock from 0.0045 to 0.0035 in.; and by reducing tube-wall thickness from 0.008 to 0.006 in. Reducing the number of fins per inch from 6 to 5 has made possible the prospect of even further savings.

News Digest

Increased Rubber Supply Urged to Meet Future Needs

Goodyear Executive Warns of Coming Rubber Shortages.

Although there is currently an ample supply of rubber, P. W. Litchfield, board chairman of The Goodyear Tire & Rubber Co., has issued a statement warning against a shortage soon to come and urged that a program to meet this situation be mapped out at once. He recommended expansion of the nation's synthetic rubber industry, creation of a synthetic rubber stockpile of 200,000 tons, and additional plantings of natural rubber in the Western Hemisphere, to yield 150,000 more tons annually, as steps in that direction.

"We should begin now to lay out a national program of synthetic rubber expansion. It should be developed in such a manner as to assure the presence of additional capacity in advance of the actual need. Existing plants should be made ready while there is still time for orderly thinking. This preventive approach to the problem of growing demand will spare us the ordeal of more drastic remedies later on."

Present synthetic plants can be modernized to provide capacity for the reserve stockpile, and this program can be put into effect quickly as a cushion against the time when rubber demand exceeds supply, he said.

The Goodyear board chairman pointed out that natural rubber is a highly volatile commodity which over the years has witnessed an almost incessant game of leap frog between supply and price. These violent fluctuations, he emphasized, strike hard at the American pocketbook while our national attitude toward rubber veers sharply between complacency and near panic. Today's improved rubber outlook follows close on the heels of the drastic shortage which began shortly after Korea and continued through 1951, with natural rubber prices soaring from a low of 18¢ per lb to a high of 84¢ at the peak.

"This pinch," said Litchfield, "cost American consumers millions and millions of dollars as well as great inconvenience; and a substantial part of this could be charged to our own failure to properly utilize our national facilities for the production of synthetic rubber. If the current easing-up period induces a recurrence of our habitual weakness for procrastination and indecision in matters of national rubber policy, then we are due for another rude awakening. And, this time, I mean very, very rude."

Current available supply of rubber to meet world needs, said Litchfield, is 2,750,000 long tons annually. It is made up of 1,000,000 tons of synthetic capacity and 1,750,000 tons from existing stands of natural rubber trees. World requirements for 1952 will be approximately 2,335,000 long tons, thus leaving a statistical surplus of around 415,000 tons.

"But," warned Litchfield, "judged by historic trends and forces now in evidence, total requirements are going to continue to climb. By 1955, world requirements of new rubber may be 150,000 tons in excess of today's total capacity. By 1960, it is accepted in informed circles, that world requirements will be not less than 400,000 long tons and possibly as much as 1,500,000 long tons in excess of our present potential capacity."

Even with increased planting of natural rubber, this source alone cannot meet our growing needs, said Litchfield, and we can look only to synthetic rubber production for the major part of the answer.

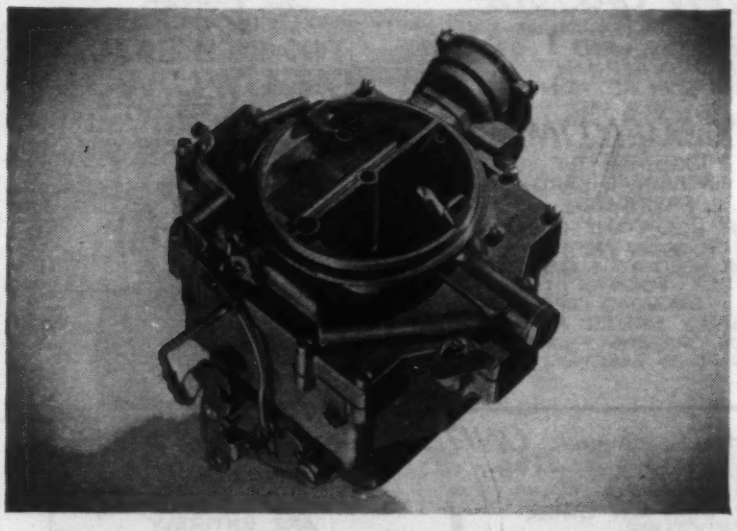
Aluminum Production Reaches New High

Aluminum production in North America is greater than the combined output of primary copper, lead and zinc on the basis of volume, I. W. Wilson, president of the Aluminum Co. of America, told the annual

(Continued on page 13)

NO REASONABLE SUBSTITUTE FOR ZINC DIE CASTINGS

These ZINC Die Castings are the principal assembly components of the new four-jet automobile carburetor pictured below. By no other means of manufacture can such amazingly complex parts be produced at anything approaching comparable cost. After simple trimming operations, only the tapping of cored holes and the drilling of additional holes at odd angles are required to prepare these parts for assembly. Die casting is, truly, the shortest distance between raw material and finished part.



This four-jet carburetor is really two carburetors in one. The primary unit alone is in use until unusual acceleration is called for (as when passing a moving car), then the second unit comes into play.

While a carburetor bowl may be an extreme example of castability, it is an established fact that the physical and economic advantages of ZINC Die Castings are such that other materials and manufacturing methods seldom can be substituted. *With ample supplies of Special High Grade zinc assured, and with die casting equipment readily available, product engineers should continue to take advantage of the economies of ZINC Die Castings.*

If you are not now using ZINC Die Castings in your products, you may be overlooking a practical means of materially lowering your costs. Consult with any commercial die caster—or write to us. Ask for a copy of "Designing for Die Casting."

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News Digest

continued from page 11

convention of the National Association of Purchasing Agents in Atlantic City. Aluminum forged into leadership in 1950, statistics quoted by the Alcoa executive showed.

"Statistics on North American production of common nonferrous metals showed that 13,250,000 cu ft of aluminum were produced in 1950," he said. "Production of copper, lead and zinc in the same year added up to 12,240,000 cu ft."

Capacity now in operation or scheduled for production by the end of 1953 will make the industry able to keep pace not only with military needs but with increasing use of aluminum in the automotive, electrical, construction and other fields, Mr. Wilson said. When Alcoa's current expansion is completed, the company will be capable of making over 6000 tons of aluminum a day. That is more than three times as much as Alcoa made just 13 years ago.

"Whereas Alcoa produced 163,500 tons of primary metal in 1939, when our current expansion is complete our company alone will be capable of producing 650,000 tons of primary aluminum annually," he said.

He pointed to aluminum's price position—the fact that aluminum today is selling at 5% below its 1939 price, while other metals are from 118 to 280% above 1939 price levels.

New Advances Made in Tin and Tin Alloy Field

The annual Report of the Tin Research Institute for 1951 mentions a number of researches which reached the stage of commercial development during the year.

Foremost is the new tin-nickel electroplate which is compared with

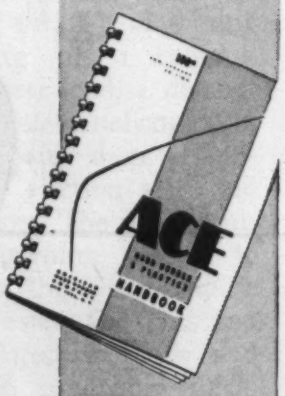
(Continued on page 216)

Please turn to page 17 for the Metal Show Preview

MATERIALS ENGINEERING FACTS

hints for molding metal inserts in ACE HARD RUBBER . . .

It takes no less than 70 pages in the new Ace Handbook to cover the amazing versatility of Ace Hard Rubber! For instance, you'll find a choice of many different compounds . . . tensile strengths to 10,000 psi, dielectric strength over 600 v/mil, heat resistance as high as 300°F., water absorption as low as 0.04% . . . in molded parts, sheets, rods, tubes and linings . . . with complete (among world's largest) facilities for design, molding, extruding, finishing . . . for thousands of applications. Always check your Ace Handbook when selecting materials for today's production and tomorrow's plans. It's free—write today.



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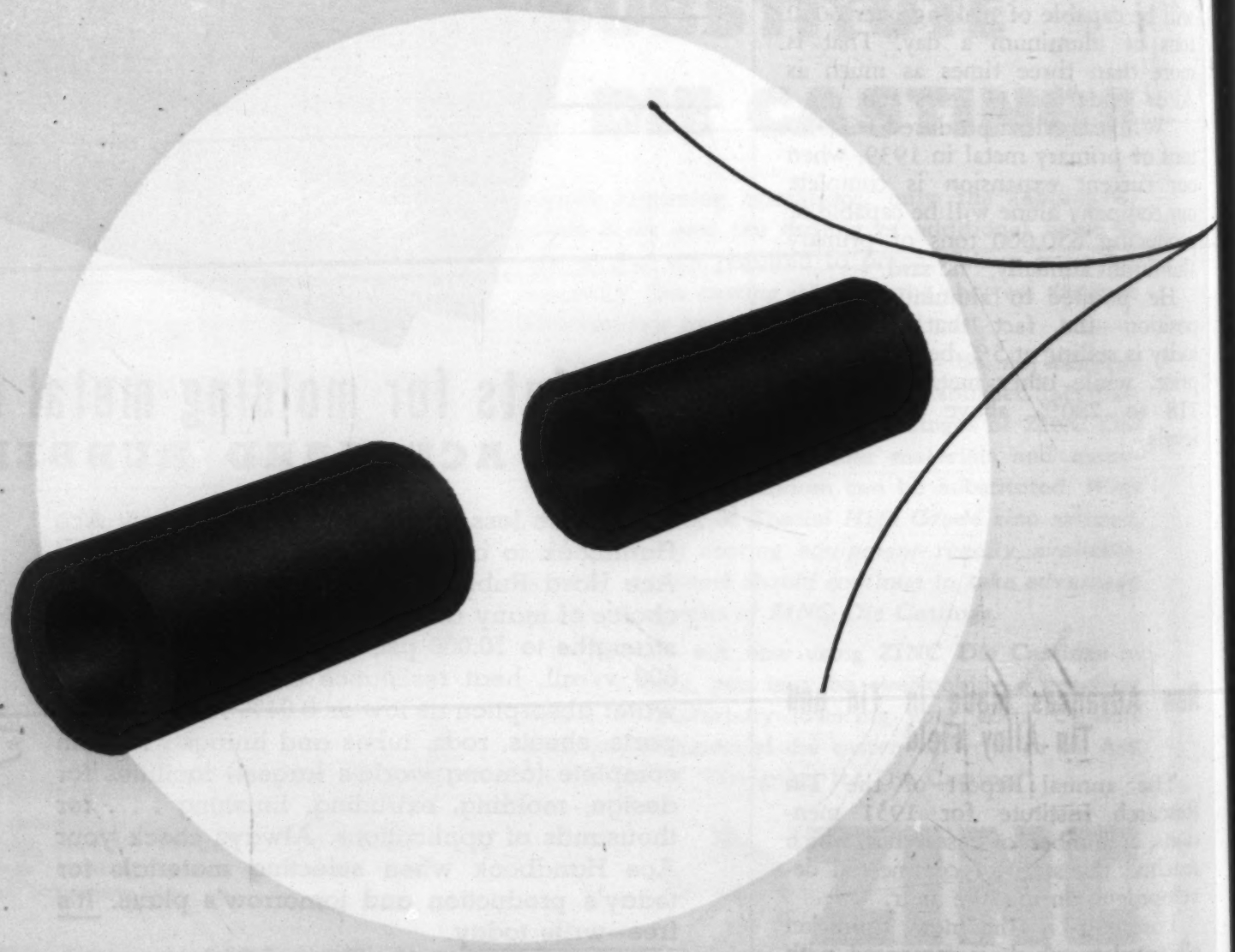

THE UNITED STATES

PREVIEW

Philadelphia Plays Host to 1952 Metal Show

The 34th National Metal Congress and Exposition will be held in Philadelphia the week of Oct. 20th. The Metal Show, as it is more generally called, will be sponsored jointly by the Institute of Metals Div. of the American Institute of Mining & Metallurgical Engineers, the American Welding Society, the Society for Non-Destructive Testing, and the American Society for Metals.

Expositions

Over 400 firms engaged in the production, treatment or fabrication of metals, or in rendering services to these industries, will exhibit. The exhibitors will use 210,000 sq ft of floor space—nearly 5 acres—in Philadelphia's Convention Hall to display and demonstrate their products, equipment and services. In addition, room has been set aside for special meetings, forums, lectures and other activities connected with the Congress and Exposition.

The exposition will be open from 12:00 noon to 10:30 P.M. on Monday, Tuesday and Wednesday, and from 10:00 A.M. to 6:00 P.M. on Thursday and Friday.

A novel feature in Convention Hall will be the bright red carpets on the aisles. The carpet will have foam rubber backing to ease visitors' steps.

A large area within the hall has been reserved for the displays of the ASM Metallographic Exhibit. Ten classifications of micros designated for the contest include: tool steels and tool alloys; stainless and heat resisting steels; other steels and irons; aluminum, magnesium, beryllium, titanium and their alloys; copper, zinc, lead, nickel and their alloys; metals and alloys not otherwise classified; series showing transitions or changes during processing; surface phenomena; results by unconventional techniques (other than electron micrographs); slags, oxides and inclusions. A committee of judges will award a first prize to the best entry in each classification. A grand prize will be presented to the exhibitor whose entry is adjudged best in the show.

Technical Sessions

Each of the sponsoring societies will have its headquarters in one of the Philadelphia hotels. Most of the technical sessions will be held at the hotels of the societies. The American Society for Metals will be at the Hotel Benjamin Franklin. The American Welding Society headquarters will be at the Bellevue-Stratford Hotel. The Hotel Adelphia will be the center of activities for the Institute of Metals Div., American Institute of Mining & Metallurgical Engineers. The Society for Non-Destructive Testing will be at the Hotel Sylvania.

The American Society for Metals will hold its annual Seminar on Saturday morning and afternoon, and Sunday morning and afternoon, Oct. 18-19. Subject of the 1952 ASM Seminar is "Modern Research Techniques in Physical Metallurgy." Throughout the week of the Metal Congress, the American Society for Metals and the American Welding Society will hold morning, afternoon and evening technical meetings. The Institute of Metals Div., AIME, will hold daily and evening technical sessions Monday through Wednesday. The Society for Non-Destructive Testing will hold sessions during four days of the week.

Other Activities

The annual meeting of the ASM will be held Wednesday morning, Oct. 22. The Edward DeMille Campbell Memorial Lecture will be delivered by Dr. Cyril Stanley Smith, Director, Institute for the Study of Metals.

The annual officers' reception and social meeting of the SNT will take place Tuesday evening, Oct. 21st. The annual business meeting of the Society will be held Thursday afternoon, Oct. 23. This meeting will follow the annual lecture honoring Dr. Robert F. Mehl, delivered by Donald T. O'Connor, Chief, Radiography Section, Naval Ordnance Laboratory.

The AWS will sponsor two educational lectures on inert gas metal arc welding. Walter H. Wooding of Philadelphia Naval Shipyard will speak Tuesday afternoon, Oct. 21 and Wednesday afternoon, Oct. 22. Both lectures will be at 4:30.

Two plant tours have been arranged by the AWS. One is a tour of either the Philadelphia Naval Shipyard or the Naval Air Materiel Center, as preferred, on Wednesday morning, Oct. 22. The shipyard tour will go through the structural shop, witnessing the fabrication of ship assemblies of steel and of aluminum. The Air Materiel Center tour will observe forming, fitting and joining practices, viewing of a catapult shooting a dead test load, a demonstration of a pilotless helicopter, a trip through the paint shop, a demonstration of the ejection seat, and a fire fighting show. The other tour, on Wednesday morning, will be to the Steam Div. of the Westinghouse Electric Co. at Lester, Pa. This trip will show the latest methods and materials used in producing steam turbines for central power stations. The latest fabrication techniques of low alloy steels, submerged arc welding and low frequency induction heating equipment for stress relieving and preheating weldments will be displayed. Many types of heat exchanger equipment and production machines will also be shown.

(Continued on page 19)

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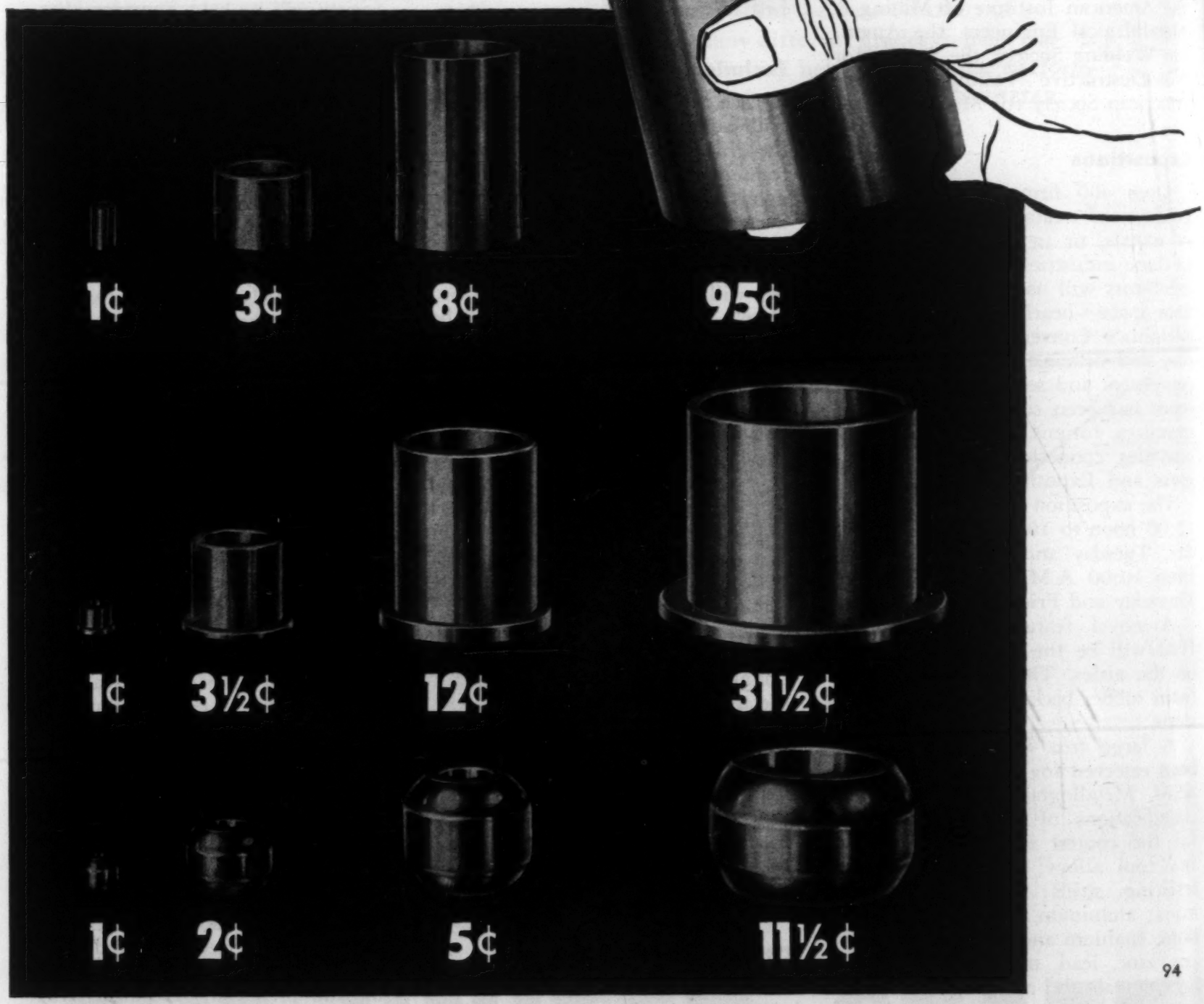

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THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

Correlated Program of Technical and Educational Sessions

National Metal Congress, Philadelphia, October 18-24, 1952

Monday, October 20

A.M.

9:00 **AIME** Thermodynamic and Thermal Properties, Hotel Adelphia

AIME High Temperature, Hotel Adelphia

9:30 **ASM** High Temperature Phases, Benjamin Franklin Hotel

10:00 **AWS** Adams Lecture on the Welding and Brazing of Titanium Alloys, Bellevue-Stratford Hotel

SNT Lowering Production Costs with Modern X-ray Equipment, Hotel Sylvania

P.M.

2:00 **AIME** Research in Progress, Hotel Adelphia

ASM Creep Rupture and Recrystallization, Convention Hall

AWS Fabricating Procedures, Bellevue-Stratford Hotel

AWS Resistance Welding, Bellevue-Stratford Hotel

AWS Hard Facing and Flame Hardening, Bellevue-Stratford Hotel

SNT New Techniques for Applying X-ray Non-destructive Tests, Hotel Sylvania

Tuesday, October 21

A.M.

9:00 **AIME** Symposium on Titanium and Titanium Alloys, Hotel Adelphia

AIME Deformation, Hotel Adelphia

SNT Control and Interpretation in X-ray Nondestructive Testing, Hotel Sylvania

9:30 **ASM** Phase Transformation, Benjamin Franklin Hotel

AWS Resistance Welding (continued), Bellevue-Stratford Hotel

AWS Weldability, Bellevue-Stratford Hotel

AWS Structural, Bellevue-Stratford Hotel

P.M.

2:00 **AIME** Physical Metallurgy, Hotel Adelphia

AIME Symposium on Titanium and Titanium Alloys (continued), Hotel Adelphia

ASM Hardenability, Convention Hall

AWS Weldability (continued) Bellevue-Stratford Hotel

AWS Resistance Welding (continued) Bellevue Stratford Hotel

AWS Brazing and Bronze Welding, Bellevue-Stratford Hotel

SNT The Economies of Nondestructive Testing to Lower Production Costs, Hotel Sylvania

4:30 **AWS** Educational Lecture on Inert Gas Metal Arc Welding Processes, Bellevue-Stratford Hotel

Wednesday, October 22

A.M.

9:00 **SNT** New Methods and Applications of Ultrasonic Nondestructive Tests to Lower Industrial Production Costs, Hotel Sylvania

9:30 **ASM** Edward DeMille Campbell Memorial Lecture, Benjamin Franklin Hotel

AWS Nonferrous Welding, Bellevue-Stratford Hotel

AWS Weldability (continued) Bellevue-Stratford Hotel

P.M.

2:00 **AIME** Titanium, Hotel Adelphia

AIME Constitutional Diagrams, Hotel Adelphia

ASM General Session (Mechanism of Delayed Yield Phenomenon, Determination of Oxygen in Metals and Metal Oxides by Isotopic Method, Indium-Arsenic System), Convention Hall

AWS Weldability (continued) Bellevue-Stratford Hotel

AWS Nonferrous Welding, Bellevue-Stratford Hotel

AWS Maintenance and Gas Cutting, Bellevue-Stratford Hotel

SNT New Electromagnetic Nondestructive Tests to Lower Production Costs, Hotel Sylvania

4:30 **AWS** Educational Lecture on Inert Gas Metal Arc Welding Processes, Bellevue-Stratford Hotel

Thursday, October 23

A.M.

9:00 **SNT** Using Liquid-Penetrant and Electrical Nondestructive Test Methods to Lower Production Costs, Hotel Sylvania

9:30 **ASM** Mechanical Properties, Benjamin Franklin Hotel

AWS Inert Arc Welding, Bellevue-Stratford Hotel

AWS Brazing, Bellevue-Stratford Hotel

AWS Marine Construction, Bellevue-Stratford Hotel

P.M.

2:00 **ASM** Temper Brittleness, Benjamin Franklin Hotel

SNT Mehl Honor Lecture on Industrial Fluoroscopy, Hotel Sylvania

Friday, October 24

A.M.

9:30 **ASM** Elevated Temperature Properties. Benjamin Franklin Hotel

AWS Pipe, Bellevue-Stratford Hotel

AWS Inert Arc (continued), Bellevue-Stratford Hotel

AWS Marine Construction, Bellevue-Stratford Hotel

See page 21 for List of Exhibitors

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OCTOBER 20-24 • BOOTH 116

INTERESTING! AMAZING! EDUCATIONAL!

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IN RING 1 →

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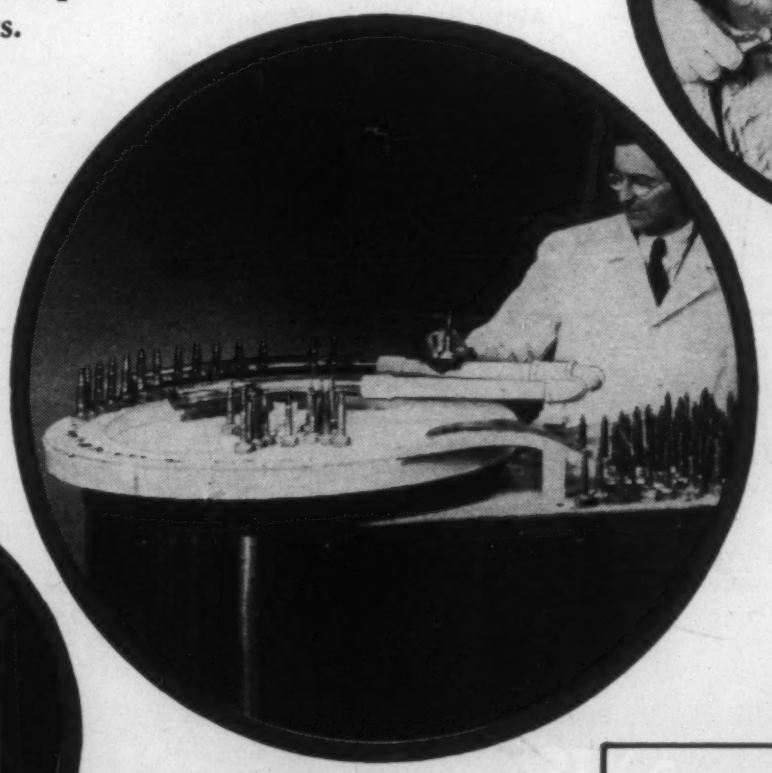
CENTER RING →

The great EASY-FLO in a stirring demonstration of production brazing—showing this alloy turning out brazed assemblies with the greatest of ease on a rotating table, gas-air heating set-up.



REVEALING SIDE SHOW

Typical case histories and examples of EASY-FLO and SIL-FOS brazing . . . Details of H&H's nation-wide brazing service and cooperation in applying the alloys . . . Brazing experts always on hand to talk with you about specific jobs.

← IN RING 3

From the four corners of Industry—four EASY-FLO and SIL-FOS brazing jobs in 2 minute motion picture shorts depicting the unmatched time-labor-cost-saving performance of these astonishing alloys.

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For a contrasting part such as a glass mold, *carboneering* by Speer produced the answer, too. Here, carbon's resistance to heat, its dimensional stability and inertness were all important in producing the desired mold.

Whatever *your* need, Speer engineers stand ready to help. Get in touch with them today—or write us, stating your problem.

LINDE'S News of Metalworking

Sigma Welding...

A Process with Outstanding Promise

Recently, the country's biggest tank car manufacturer received the largest order for aluminum tank cars ever issued — ninety-eight tank cars on a single order. This order was obtained only because of the development of a fully automatic welding process . . . shielded inert gas metal arc welding — sigma welding.

This welding process has made double-vee butt welds at 5 in. per min. in 1-in. material. Structural welds have been made at 48 in. per min. in ¼ in. plate, and as high as 200 in. per min. on 1/16 in. material.

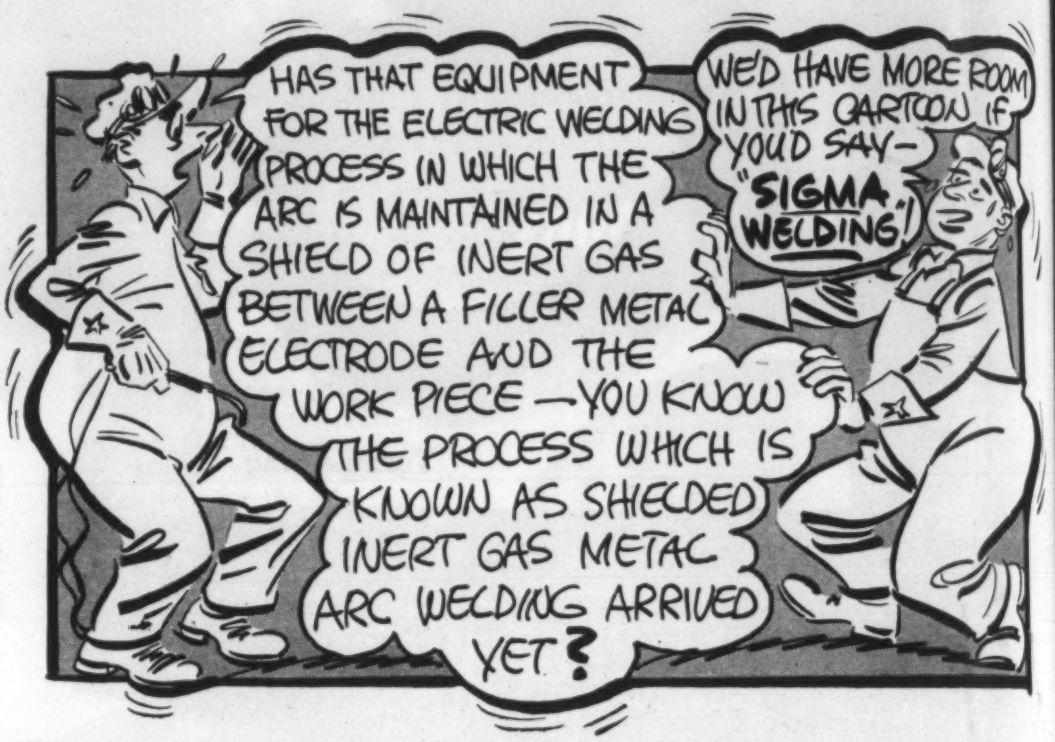
Prior to the development of sigma welding, fabricating aluminum tank cars was a slow hand process. In order to weld the heavy plates used in making the cars, as many as six passes were required.

With an automatic sigma welding setup, X-ray quality welds in the ½ to 1¼ in. thick aluminum plates are made at speeds of from 6 to 15 in. per minute. And only 2 passes, one inside and one outside, are required to get perfect penetration. High current densities used in sigma welding result in narrow welds with deep penetration.

Sigma welding is fast becoming an important fusion welding method. It has not only replaced many other welding methods, but has permitted fabrications hitherto impracticable for welding.

Just recently, a metalworker adopted this process for welding an aluminum-bronze valve seat to a mild steel tube . . . sigma welding proved to be the only practical method he could use for this work.

Another shop built their first *aluminum tank using sigma welding* . . . The large tank was finished so quickly — work progressed without stopping — that the shop will replace all other welding methods with sigma welding. Excellent welds *requiring little finishing* were obtained in the ⅛ in. aluminum plates.



New Processes Need New Names

The cartoon shows just about the way it started . . . Shielded inert gas metal arc welding was quite a mouthful to say when describing or referring to the process. It also required a lot of space in written material.

Then someone said sigma welding. It was easier to say.

Sigma is a good word, too. Each of the letters is an initial letter of the words: shielded, inert, gas, metal, and arc.

This easy-to-say word, sigma, is now used to describe the process. It is not a trade-marked word, and is used in the same sense as oxy-acetylene welding, gas cutting, or brown dog — just like any other descriptive adjective.

Metals Being Joined by Sigma Welding

Sigma welding can be used on practically all commercial metals. Railroad tank cars, chemical and food processing tanks, pressure vessels, and brewery equipment are only a few applications where the process is being used economically. Here's a quick look at some of the metals being joined by this process:

Aluminum . . . All weldable grades including 3-S, 50-S (150-S), 52-S, 61-S, and the commercially pure 2-S alloy are being welded with excellent results . . . These alloys are being machine welded in thicknesses ranging from 0.50 in. to 1.50 inch . . . Hand welds are made in material ⅛ in. and thicker . . . Maximum thickness that can be welded is unlimited with multi-pass technique . . .

Stainless Steel . . . Sound X-ray quality butt welds have been obtained in thicknesses ranging from ⅛ to ½ inch . . . Quite evident that heavier thicknesses can be welded . . . Results of tests show that welds possess good tensile strength, elongation, and impact resistance . . .

Copper . . . Sound butt, fillet, and corner welds have been made in ⅛ in. and ¼ in. deoxidized copper.

Everdur . . . Butt welds made in ⅛, ¼, and ½ in. thick materials are sound, smooth, and without cracks or undercutting. Tests showed that bend and tensile specimens have excellent properties.

Carbon Steel . . . Sound machine butt welds have been made in ⅛ in., ¼ in., and ½ in. thick killed and semi-killed carbon steels . . .

Aluminum Bronze rod has been deposited on mild steel with excellent results . . . Wear resistance greatly improved . . . Other surfacing and buildup operations very successful . . .

Materials & Methods
October 1952

General Purpose High Temperature Alloys

What They Can Do

Where To Use Them

These metals—carbon steels, low and high alloy steels, stainless steels, and nickel-base alloys—are the most widely used in high temperature applications today.

by KENNETH ROSE,
Western Editor, Materials & Methods

● THE RANGE OF materials suitable for high temperature service is wide, including both metals and non-metals. Because the metals possess both strength and good fabricating possibilities, they are usually chosen for primary structures, and for most load-carrying accessories also.

Of the metals used for high temperature service in industry, an arbitrary but useful classification might be made into a specialty group and a general purpose group. The specialty group would include the noble metals, especially those of the platinum family, which are much too costly for most applications; such metals as molybdenum, tantalum and tungsten, which possess high melting points but must be given special handling, either in service or in fabricating; and those alloys usually called the engine alloys, mostly cobalt-base alloys high in cost and difficult to fabricate.

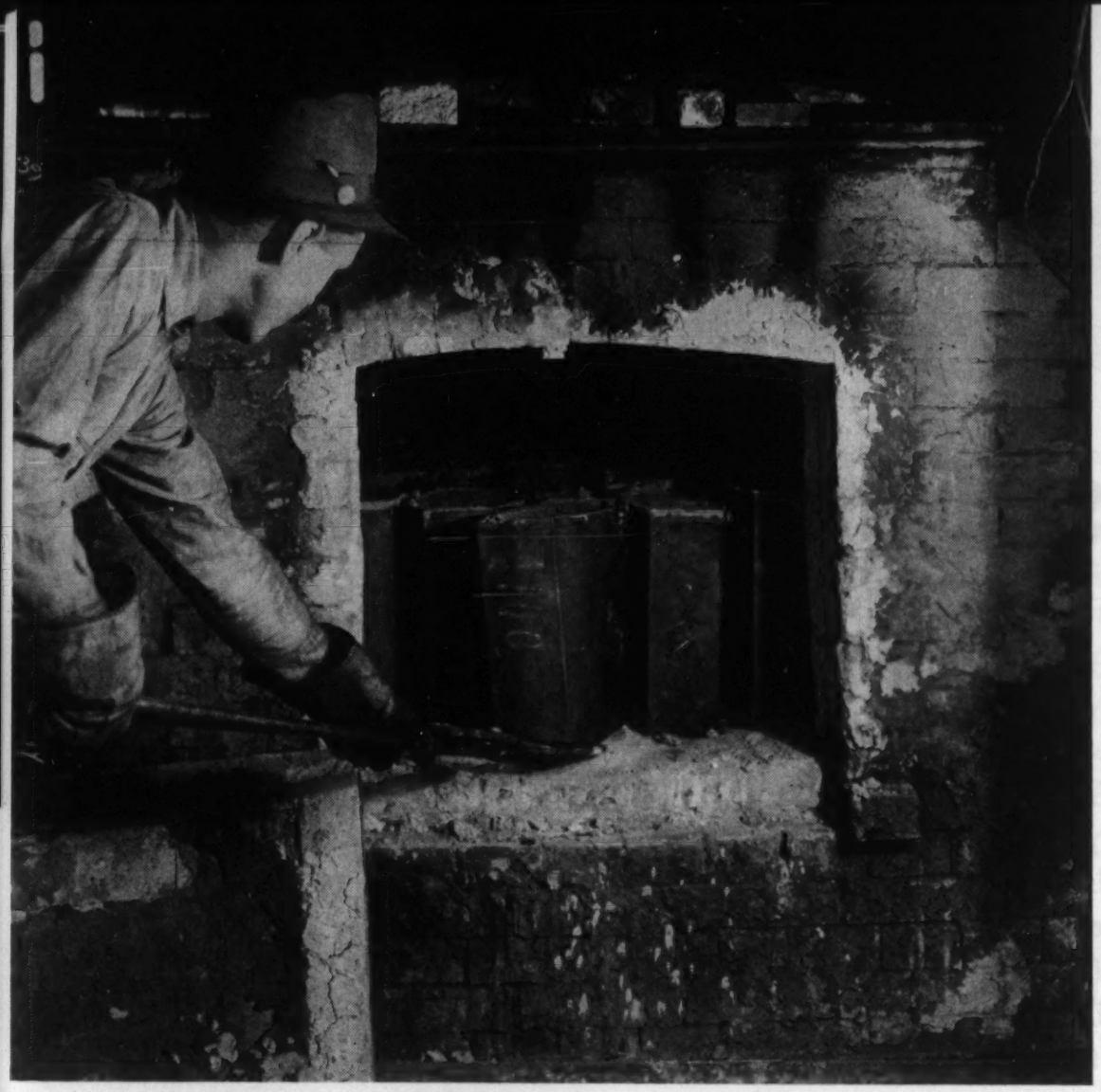
It is the general purpose group, however, that provides by far the bulk of the high temperature alloys in service. This group includes: (1) plain-carbon steels; (2) low-alloy steels; (3) stainless steels; (4) high-alloy steels; and (5) nickel-base alloys. There are no sharp lines of division among the highly alloyed types. The nickel content of steels can range from a few percent to the point where nickel is the major constituent, and they are actually nickel-base alloys. Likewise, the term "general purpose" does not accurately describe some of these highly alloyed materials, which are really specialty metals for such applications as electrical heating elements.

One point of difference between the general purpose alloys and the so-called super-alloys, or jet-engine alloys, is worth noting. The engine alloys are intended to be used at maximum service temperatures of about 1600 to 1650 F, and to possess a relatively short service life, but with high strength at service temperature. Some of the general purpose alloys are used at temperatures of 2000 F and slightly higher, and give relatively long service life at these temperatures, but they could not meet the strength requirements of the engine alloys.

A major difficulty in evaluating high temperature alloys is the complex nature of the problem. While a part may fail by breaking under load at the service temperature, corrosion rather than inadequate mechanical strength may have been the prime cause of failure. Even where strength is adequate for short-time loading at the service temperature, the part may fail under long-continued stress. The structural stability of the alloy is an important factor in many applications also.

Finally, it has been found that a rather wide range of values for high temperature tensile strength can be obtained with material of the same composition if the pre-service heat treatment of the pieces has varied. This is especially true of the steels. The inter-related factors of (1) heat, both as to degree and continuous or intermittent application, (2) stress, long-time or short-time application, (3) corrosion, by air or by special or corrosive atmospheres, (4) possibility of phase change, and (5) grain size of the alloy, make it difficult to compare one alloy with another by rating them in terms of top service temperature. It is possible, however, after pointing out the complicating factors, to set ranges of temperature in which the materials will give best service and to qualify the statement with such special notations as apply.

In the preliminary heat treatment of steels, including mill processing,



Carbon brushes produced by the Superior Carbon Products Co. are packed in sand in these Type 309 stainless steel pots and baked for an average of 48 hr at 1400 to 1750 F. Carbon steel pots burned out after three or four heats, often ruining the contents when a hole was burned through the pot and the brushes were oxidized. The Type 309 pots have an average life of more than 100 heats. (Republic Steel Corp.)

Group of radiant heating assemblies cast from Fahrite at Ohio Steel Castings Co.

an annealed structure is generally desirable. Further, it has been shown that, of two pieces of steel of the same composition, the piece with the coarser grain size will have the higher creep strength and rupture strength above the so-called equicohesive temperature.

Carbon and Low Alloy Steels

Carbon steels are important elevated-temperature materials for such purposes as the outside walls of furnaces, for smokestacks and breeching, and for boiler tubes and plates in low-pressure equipment. They are important in oil refinery equipment also. Plain-carbon steels are the lowest-cost alloys available for high-temperature service. They have the widest range of fabricating possibilities, as they can be cast, welded, hot or cold formed readily. However, they resist corrosion in ordinary air at room temperature only if protected. At elevated temperatures, a powdery red oxide forms at about 1000 F in air, and at higher temperatures, an oxide scale forms quickly. Their poor resistance to corrosion is one of the limiting factors in the use of carbon steels for high temperature service, where the protective coatings that can be used satisfactorily are few in number.

The addition of molybdenum to the carbon steels causes a substantial increase in creep and rupture strengths. Addition of chromium does not seem to cause further increase in strength below 1000 F, but small additions of that element or silicon raise the creep and rupture strengths somewhat at temperatures above 1000 F, probably due to increased corrosion resistance. Silicon seems to be most useful in amounts not exceeding 1.25%.

The low-alloy steels are primarily structural steels intended for service at ordinary temperatures. The small alloy content provides some increase in resistance to atmospheric corrosion, and the high yield point and increased tensile strength, combined with the increased corrosion resistance, permit use of lighter sections when these steels are used to replace carbon steels. The same properties are of value in elevated-temperature service. While the dozen or so types of low-alloy steels of various compositions have somewhat different properties at high temperatures, they correspond to those of the plain-carbon steels with the advantage of somewhat increased tensile, creep

and rupture strengths. The carbon steels and these low alloy steels are generally limited to service temperatures up to about 800 to 1000 F.

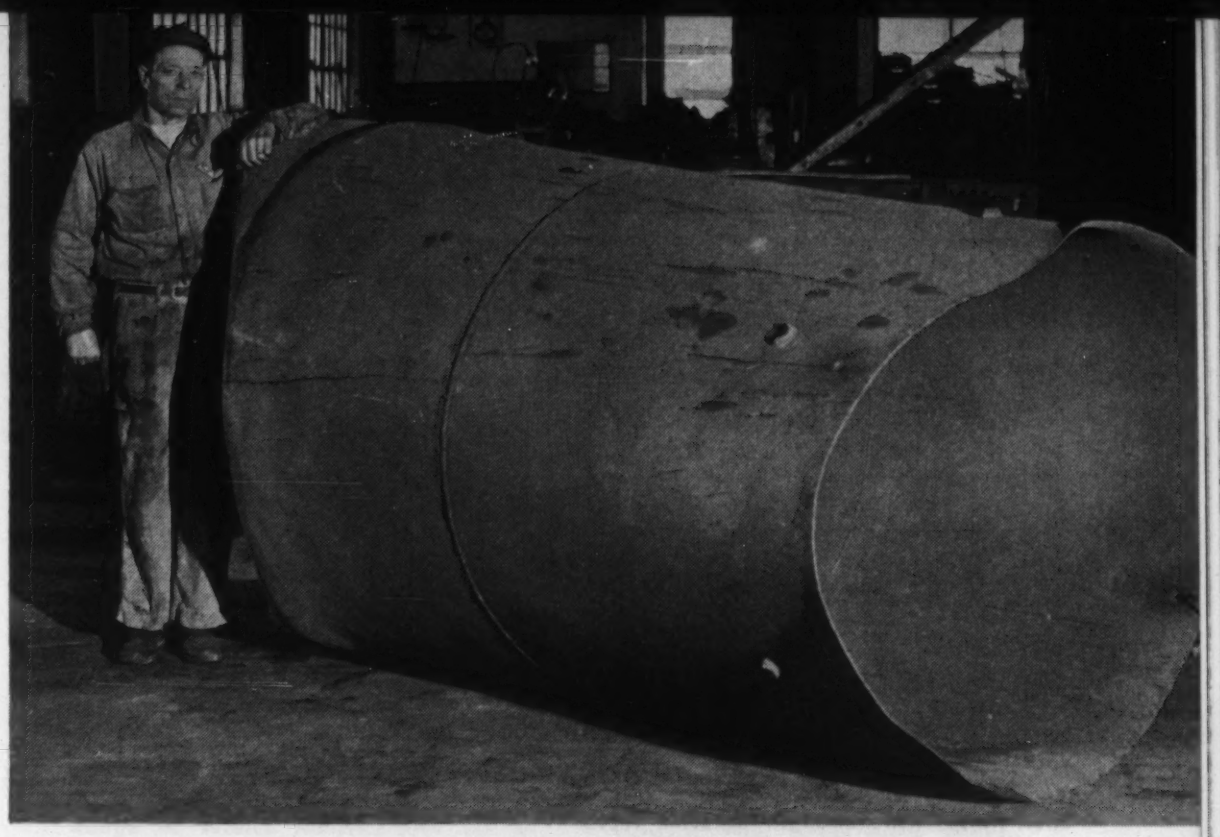
Unfortunately, the present shortage of molybdenum and nickel has sharply limited the production of most types of low-alloy steels, including some of those that would be of most value in elevated-temperature work. While this situation is temporary, and allocations can be obtained in some cases, it must be recognized that many of these steels are at present unavailable except for military orders.

Stainless Steels

A group of iron-chromium alloys, including the "straight-chromium" stainless irons, is the first of the truly heat resistant steels. Some of these are ferritic, some are martensitic. In general, the ferritic alloys do not have good hot strength. The compositions in the 5 to 15% chromium range are air hardenable, except where titanium is added to the 5% chromium material, or aluminum to the 12% chromium alloy. They have rather low strength. In the high-chromium range they are most useful in applications where resistance to high-sulfur atmospheres is a part of the requirement. However, when there are sharp bends in tubes carrying gases containing a small amount of sulfur, the life of the metal may be greatly shortened, an effect which can occur also if moisture or oxygen are present.

The 5% chromium steel is largely used in oil refinery equipment, where it shows fairly good corrosion resistance to sulfur-bearing crudes, but resistance to atmospheric corrosion only slightly better than mild steel. It has reasonably good scaling resistance to about 1150 F.

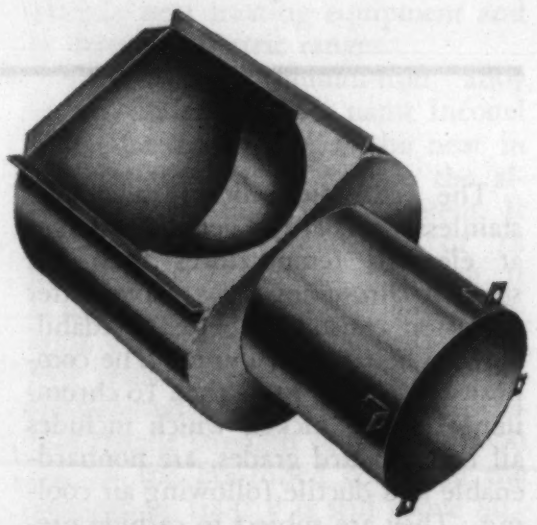
The chromium types of stainless steels, containing approximately 12 to 27% chromium, are lower in first cost than the chromium-nickel types, but are generally more costly to fabricate. They are not susceptible to intergranular corrosion and have low coefficients of thermal expansion. Those containing more than 22% chromium show better resistance to sulfur-bearing gases than the chromium-nickel types. Where the application requires repeated heating and cooling, the chromium grades may show less scaling than the chromium-nickel grades, due to their lower expansion and contraction and the resulting lessened tendency for the protective scale to crack off.



Baffle plate of Type 309 steel from a pit-type annealing furnace which was removed because of warping after nine years continuous exposure at 1800 to 2000 F. (Republic Steel Corp.)

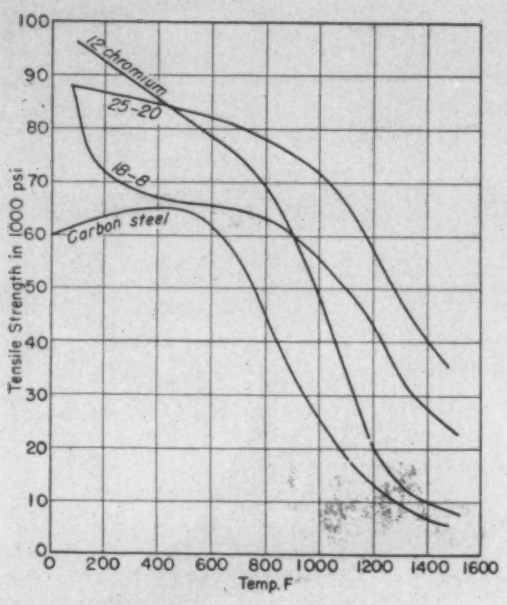
There are several variations of the 12% chromium grade, made by slightly changing the alloy content to meet specific conditions. The basic type (410) is suitable for service to about 1250 F, where corrosive conditions are not too severe and the stresses are relatively low. It is much used in valves for steam control up to about 950 F, and for trays and liners in oil refinery equipment. Type 403 is intended especially for steam turbine blades and other parts exposed to steam at temperatures up to 950 F. If the fabricating procedure is to include welding, Type 405, an aluminum-bearing variation, can be specified because it does not harden upon cooling from elevated temperatures. A free-machining variation, Type 416, would be the choice if the parts require considerable machining. Addition of the 2% nickel to the basic 12% chromium composition produces Type 414 having better mechanical properties, and used for such parts as valve seats and exhaust port inserts.

The 17% chromium steels are widely used heat resisting grades of stainless steels. The basic type is 430, and a free-machining variation is designated 430 F. These compositions have good corrosion and scaling resistance to about 1550 F, but are not recommended for applications that require resistance to shock or vibration. They are much used for combustion chambers in gas- or oil-fired furnances, as they possess good resistance to sulfur-bearing gases. They tend to be somewhat brittle at room temperature after heating in or slowly cooling through the 700 to 1100 F range.

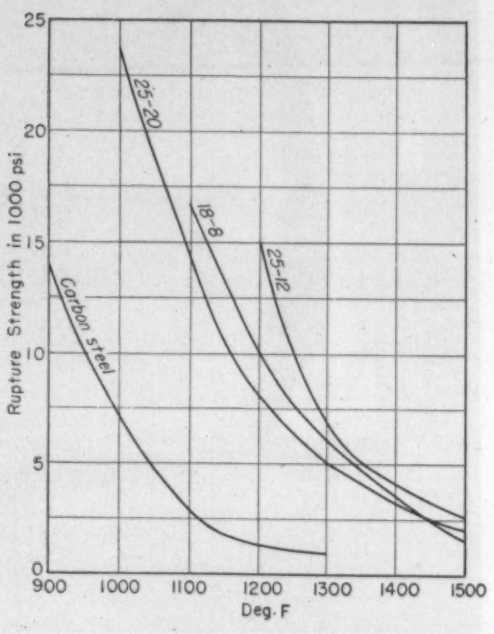


Combustion chambers of domestic oil-fired furnaces must resist destructive scaling at temperatures up to 1400 F when the furnace is in operation and severely corrosive condensates when idle. Welded combustion chambers of Armco 17, Type 430, have proved troublefree and long-lived.

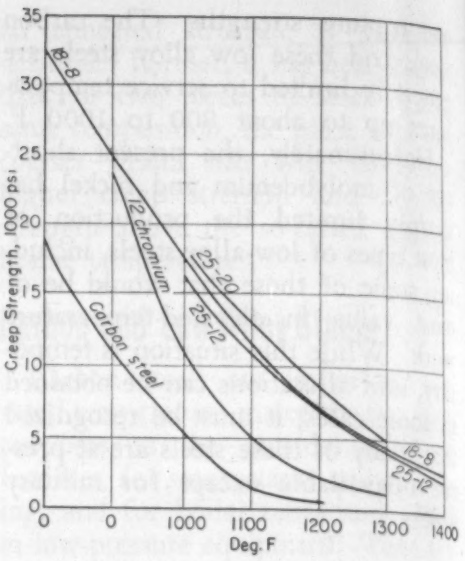
Stainless steels containing 23 to 27% chromium are listed as Type 446 in the wrought alloys, and a cast alloy of 28% chromium content is designated HC by the Alloy Casting Institute. These alloys have good resistance to oxidation and to sulfur-bearing atmospheres to about 2000 F. They are not high-strength alloys, however, and like the Type 430 alloy, tend to become brittle if heated for prolonged periods in the 700 to 1100 F range. They are used for burner tubes, for muffles in industrial furnaces, for combustion tubing, furnace control valves, electrical contact points, etc.



Short-time tensile strength of some representative steels at elevated temperatures. (Adapted from Miller and Heger, Carnegie-Illinois Steel Co.)



Elevated temperature rupture strengths of several steels. (Adapted from Miller and Heger, Carnegie-Illinois Steel Co.)



Creep strength for a rate of creep of 1% in 10,000 hr for a number of steels. (Adapted from Miller and Heger, Carnegie-Illinois Steel Co.)

The chromium-nickel austenitic stainless steels are in general stronger at elevated temperatures than the straight chromium types, have better corrosion resistance, better weldability, and better formability. The compositions having more than 16 chromium and 7% nickel, which includes all the standard grades, are nonhardenable and ductile following air cooling. They are subject to carbide precipitation and consequent intergranular corrosion, but this condition is controllable by holding the carbon content to a low figure, or by adding a stabilizing element.

The basic alloy of 18 chromium, 8% nickel (Type 302) is one of the most versatile of the stainless steels. It has wide fabricating possibilities and good resistance to scaling up to about 1650 F. Slow cooling through the 900 to 1300 F range encourages carbide precipitation and should be avoided. The material is used for airplane fire walls, valve parts, gas heater guards, etc. A low-carbon variation of the basic formula, Type 304, is used to minimize carbide precipitation, and an extra-low-carbon grade (Type 304 LC) is used where welded pieces cannot be subsequently annealed. The cast variety of 302 is designated HF, and has a nominal composition of 20 chromium, 10% nickel. A variation upon the 302 basic type is Type 302B, in which an increased silicon content gives better resistance to oxidation at high temperature. Type 303 is a free-machining grade of 302. Stabilized grades are Type 321, with a nominal composition of 18 chromium, 10% nickel, plus titanium, and Type 347, with the same nominal composition but stabilized by addition of columbium. These stabilized compositions can be used as welding grades and for service in the 800 to 1650 F range in which the nonstabilized forms are unsatisfactory.

Types 316 and 317 are 18:12 and 19:12 compositions, respectively, in which molybdenum is added principally for enhanced corrosion resistance and secondarily to improve the tensile strength, creep strength and rupture strength at elevated temperatures. Resistance to chemical corrosion by reducing acids is also better than the 302 type. Both are made in extra-low-carbon grades that are suitable for welding, and also for service in corrosive atmospheres at 800 F or lower, where the 302 alloy may not be sufficiently resistant.

The alloy with 25 chromium, 12% nickel (Type 309) as its nominal composition is much used in heat treating furnaces for muffles, annealing baskets and boxes, and thermocouple wells, and for flash boilers in aircraft. It combines good strength properties at high temperatures with good corrosion and scaling resistance. The same alloy in cast form is designated HH, and comprises about one-third of all heat resistant castings during normal times. The composition must be carefully balanced to keep it in the austenitic condition, otherwise there will be danger of embrittlement from prolonged exposure in temperature range 1200 to 1600 F. These alloys have good oxidation resistance to about 2000 F.

For temperatures slightly higher than the best service range of the 25:12 material, a cast alloy with nominal composition 28 chromium, 15% nickel is used. It has good resistance to oxidation at 2150 F, and is Type HI in the Alloy Castings Institute listing.

Alloys 310 and 314 are nominally 25:20 compositions, the latter with silicon added to increase scaling and carburization resistance. The cast alloy of the same composition is HK. These alloys are serviceable to about 2000 F. They give better service in high-sulfur atmospheres than the compositions higher in nickel.

A composition that is really a modification of one of the straight-chromium alloys is the cast alloy HD, with 28 chromium and 5% nickel. It greatly resembles the cast composition HC, with somewhat greater strength at high temperatures and a little more ductility. A wrought version modified by the addition of 1.5% molybdenum is available as Type 329.

For increased resistance to sulfurous and other corrosive gases at

high temperatures the chromium content of the 25:20 alloys is increased to 30% chromium in the HL alloy. This cast alloy is especially useful when service temperatures are about 1800 F in corrosive atmospheres.

High Alloy Irons and Steels

In the next group of alloys the compositions shade from the highly alloyed iron-base to the nickel-base materials. The four cast alloys comprise the largest volume of all heat resistant alloys cast, and are used for fixtures and trays for heat treating furnaces and parts for enameling furnaces. They are resistant to carburization, and are much used for carburizing furnace parts. The scale formed does not tend to flake off, making them useful in enameling furnaces where falling scale would mar the workpieces.

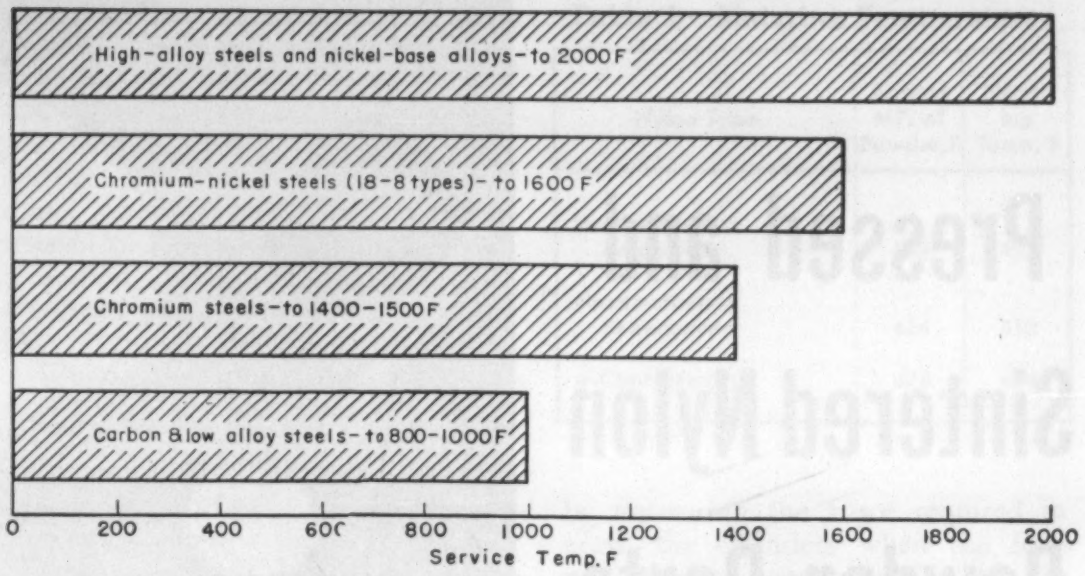
Through the series designated by HT, HU, HW and HX the resistance to carburization increases as the nickel content increases. High temperature tensile strength decreases slightly, but resistance to thermal shock increases. Resistance to corrosion and oxidation improves as the chromium content increases. The wrought version of these alloys is Type 330.

Alloy HT, with a nominal composition of 35 nickel, 15% chromium, is the most used of the group. It has satisfactory resistance to 2100 F in oxidizing atmospheres, and to 2000 F in reducing atmospheres. Addition of a small amount of silicon reduces the tendency of boxes to carburize during pack carburizing operations.

Composition 39 nickel, 19% chromium is designated HU, and possesses slightly better strength at elevated temperatures. It may be chosen in preference to the HT alloy for severe service.

Casting alloy HW is not quite as strong as the two preceding materials, but has better resistance to oxidation, carburizing, nitriding and thermal shock. It is used for retorts and furnace parts. Because of its high electrical resistance it is sometimes used for cast electrical heating elements. The nominal composition is 60 nickel, 12% chromium. It can be used to 2050 F in oxidizing atmospheres, and to 1900 F in reducing atmospheres. Because of its high nickel content, it is not recommended for high-sulfur atmospheres.

The alloy HX, with a nominal composition of 67 nickel and 17% chromium, is more corrosion resistant than others of the group at high temperatures. Because of the high chromium content, it is somewhat better in contact with sulfurous gases than HW. Both HW and HX can withstand repeated heating and cooling without cracking or warping, and are often chosen for quenching fixtures. They are highly resistant to carburizing, and are resistant to the neutral salts used in some salt baths.



Range of service temperatures for general purpose high temperature alloys.

Nickel-Base Alloys

In these last alloys nickel is the major constituent, and they are properly called nickel-base alloys rather than iron-base materials. There are several other alloys that are definitely nickel-base, and these are of great importance as heat resistant alloys. In general, the nickel alloys have excellent resistance to corrosion at high temperatures, except by sulfur-bearing gases; have good high temperature strength, and low electrical conductivity. They are highly resistant to carburizing or nitriding atmospheres—in fact, the high-nickel alloys can be carburized or nitrided only with difficulty. This makes them excellent materials for fixtures to hold or carry work in such heat treating procedures.

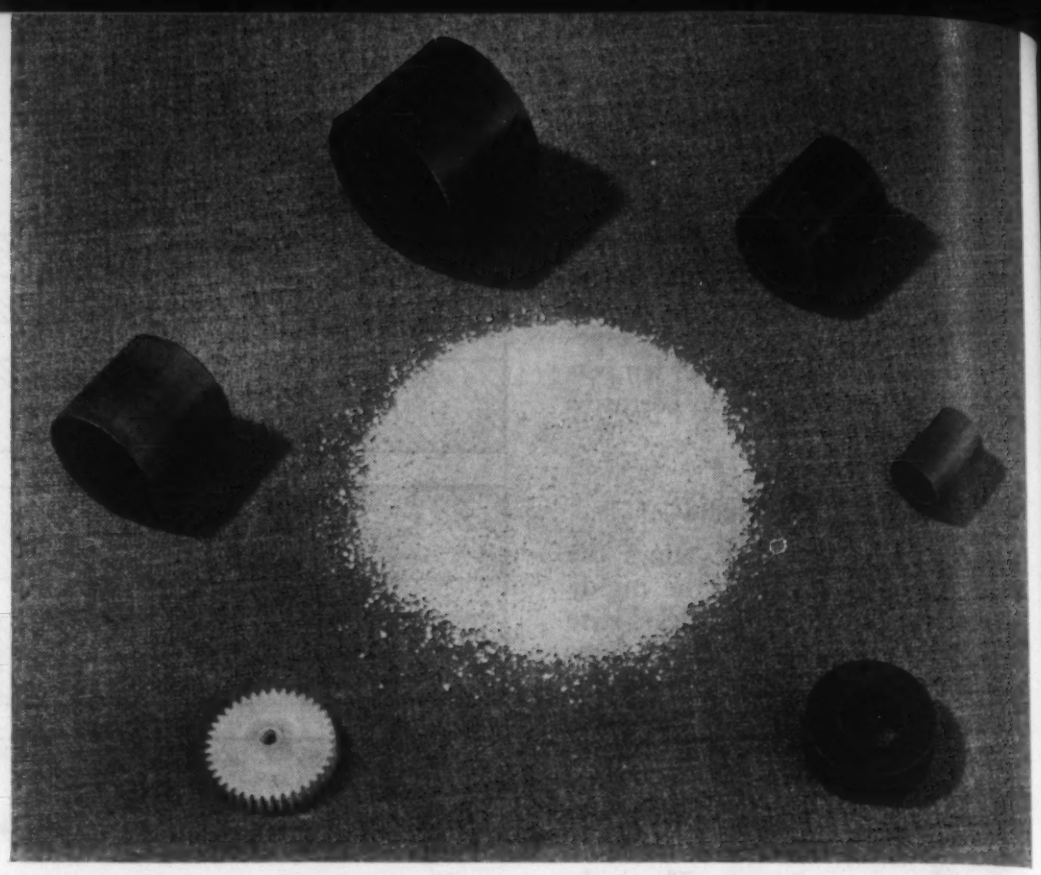
The alloy in this series that has the lowest nickel content is Incoloy, which contains 34 nickel, 21% chromium and the balance iron. This alloy was designed to conserve scarce alloying elements and to supplement Inconel in normal times. Its room temperature properties fall within the range of those of Inconel while its creep and rupture properties run slightly lower. It has been used in heat treating equipment and in domestic electric ranges.

The nickel-chromium-iron alloy known under the trade name Inconel might be thought of as the next in a series that would include the alloys of increasing nickel content. It has a nominal composition of 78 nickel, 15% chromium, 6% iron. It is usable to about 2100 F, and maintains good creep strength and excellent resistance to oxidation at high temperatures. With a room-temperature tensile strength of about 90,000 psi, in the hot-rolled condition the strength at 1000 F is still above 80,000 psi, but it begins to fall rapidly at higher temperatures. Creep strength is likewise high until temperatures exceed 1000 F. Service temperature should not exceed about 1500 F if the sulfur content of the atmosphere is appreciable.

An age hardening variation of the basic composition termed Inconel X is used as an engine alloy for turbine blading, etc., and for springs that are suitable for use at temperatures up to 1000 F. It is used for other purposes in which a high creep strength must be maintained at 1200 to 1500 F under high stresses, with good oxidation and chemical resistance.

For service at elevated temperatures in sulfur-free atmospheres, when high strength is not a primary requirement, pure nickel is an important material. It resists temperatures to about 2300 F, and is especially useful in controlled atmosphere furnaces using reducing atmospheres. In sulfur-containing atmospheres, the service temperature should not exceed about 600 F.

Pressed and Sintered Nylon Powder Parts



Nylon powder lends itself to production of sintered nylon bearings, gears, cams, valve seats and other industrial products.

—A New Development That Means:

- ***Better dimensional stability***
- ***Less internal strains***
- ***Improved bearing properties***
- ***Wider range of fillers to provide special properties***

by LOUIS L. STOTT, Polymer Corp., and

LAURENCE R. B. HERVEY, Arthur D. Little, Inc.

● THE DEVELOPMET OF new and unique finely divided nylon powders made from the high melting nylons such as polyhexamethylene adipamide (FM10001) have made possible a fabricating technique similar to that used in the powdered metallurgy industry. These nylon powders can be cold pressed and sintered below the melting point into articles such as bearings which are unusually wear resistant and have excellent frictional properties, particularly where lubrication problems exist. Objects prepared in this way appear to show better dimensional stability than conventionally molded nylon articles. Moreover, the process is more adaptable to the addition of fillers than usual molding techniques, the dimensional stability being still further improved thereby. A wide range of fillers may be incorporated with the powders in the dry state, thus eliminating the danger of segregation, which is present when fillers are added to molten nylon.

In addition to achieving lower hygroscopic or thermal changes, the process of cold pressing and sintering high melting nylons appears to result in a finished object containing less internal strain than is normally found in a conventionally molded piece. This is thought to be due to the fact that the polyamides of this type have a relatively high volumetric contraction on solidifying from the melt, necessitating application of considerable external pressure during solidification to avoid voids in the finished piece. Whatever the cause, the presence of strain in such articles as injection molded or machined nylon bearings is believed to have been an important cause of the somewhat erratic behavior of such pieces sometimes reported. Such strain can be relieved in large measure by annealing procedures, but it is interesting to note that cold pressed and sintered articles seem to have less of it, with consequent improved dimensional stability in service.

Pressing and Sintering Method

In general, this new technique of fabricating nylon follows rather closely conventional powder metallurgy practice. The powdered nylon, designated Nylasint (tradename, National Polymer Products, Inc.), is compressed while cold in a mold designed to give the desired shape. The molded preform is then heated to bring about sintering. Pressures of the order of 25 tons per sq in. appear satisfactory, although press-

ing at 5 tons per sq in. can be used with only a slight loss in strength. In some cases higher pressures may be advantageous to get a little better strength or greater density.

The physical characteristics of the powder itself appear to be the most critical factor in the process. The chemical process employed yields particles of the order of 1-3 microns in dia. Mechanically pulverized nylon, having a particle size in the order of 50 microns, is wholly useless as manifested by insufficient strength to permit removal of the preforms from the mold.

In the actual sintering operation it is essential that air be excluded since otherwise the sintered objects have very low strength. This can be accomplished by sintering in an inert gas, such as nitrogen or carbon dioxide, in a vacuum, or immersion of the preforms in hot oil. In the latter process it is usually desirable to immerse the objects in oil below 212 F, and raise the temperature to the desired point over a period of approximately ½ hr. Otherwise moisture and air contained in the preform tend to cause cracks and other imperfections. Some oils have sufficient solvent effect on nylon at the sintering temperature to soften it and cause distortion. Meprolene, a well known heat transfer oil, is satisfactory. One of the Ucon lubricants (50 HB280X Carbide & Carbon Chemicals Corp.), said to be an oxidation inhibited polyethylene glycol derivative, is also an excellent sintering medium.

After bringing the sintering bath to temperature, it is held there for a sufficient time to permit adequate sintering. This varies with the size of the object, but even for quite large objects, such as bars 2 in. in dia, 1 hr appears to be adequate. The bath is then cooled to a temperature low enough to permit handling, after which the objects are wiped to free them from oil; or, if desired, they can be washed with a solvent such as carbon tetrachloride.

While the oil sintering process is satisfactory for most purposes, there is a slight penetration of oil into the object with the result that the outermost surface is darkened. Therefore, where a light colored object is desired or where the piece has very thin sections, such as the teeth of small gears, sintering in vacuum or in an inert gas is preferable. This method is more cumbersome and is used only when oil sintering is impractical.

The sintering temperature varies, depending upon the polymer used. It is usually close to the melting point of the powder and must, therefore, be accurately controlled to within 4 F. The preferred sintering temperature of the more common nylons are given in Table 1.

It will be noted that the sintering temperature is fairly near to the melting point in most cases. When operating at lower temperatures strength is sacrificed, as shown in Fig 1, where sintering temperature of polyhexamethylene adipamide is plotted against the strength of hollow cylinders ½ in. I.D., ¾ in. O.D., and 1 in. long. The strength values were determined by measuring the force required to crush the cylinders when the load was applied perpendicular to the axis.

Table 1—Sintering Temperatures

Nylon Type	Approx MP. of Powder, F	Sintering Temp, F
Hexamethylene Adipamide	509	493
Hexamethylene Sebacamide	424	410
e-Caprolactam	428	424

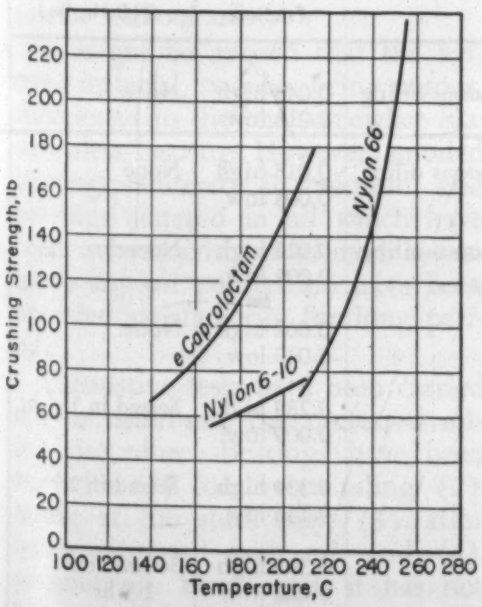


Fig 1—Strength vs sintering temperature.

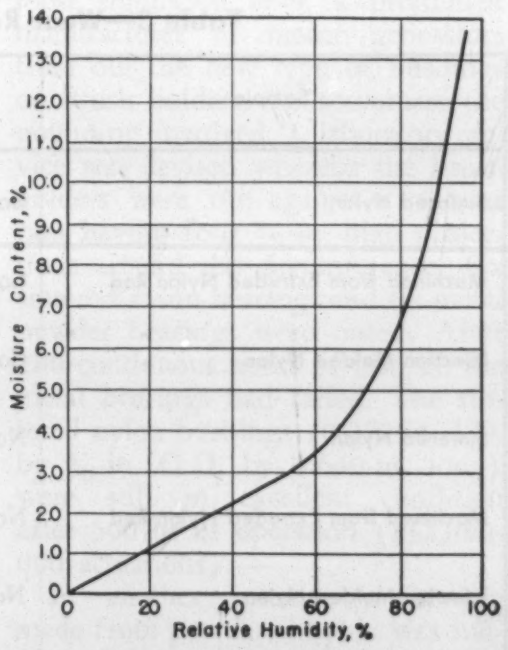


Fig 2—Moisture content of nylon powder when at equilibrium in various relative humidities.

Certain precautions must be observed in handling the powder. Presence of moisture introduces difficulties during sintering, and, therefore, the powder should not be exposed to humid atmospheric conditions since it picks up moisture readily (see Fig 2). For making most small objects, a moisture content of more than 1% in the powder is objectionable. In large sections, it should not be more than 0.4%.

If the powder becomes damp so that it is necessary to dry it before use, drying should be carried out at not more than 122 F, and preferably in a vacuum. Both heat and oxygen are detrimental, and powder which has been overheated or allowed to remain in contact with oxygen yields finished objects of low strength. The effect of oxygen is extremely slow at room temperature, but at 212 F it is sufficiently rapid so that exposure for 12 hr spoils the material completely. However, oxidation is detrimental only to the powder since unsintered preforms are apparently affected to only a relatively slight degree at temperatures as high as 212 F.

Fillers Easily Added

As mentioned above, one of the principal advantages inherent in this sintering technique is that various fillers can be incorporated with ease, and there is no problem of settling out as when certain heavier powders are incorporated in molten nylon. Thus, materials can be added which serve in the finished object to make it self lubricating, electrically conductive or susceptible to magnetic attraction. Also, if greater porosity is desired, inorganic salts added after sintering can be extracted with water to yield products of varying porosity.

Various fillers can be added by merely tumbling the two powders together. While the ability of the nylon to bind various additives without serious loss of strength may vary as a result of their nature, in the case of copper and graphite quantities up to roughly 80% by volume can be incorporated without detriment to the object.

Lead is of particular interest as an additive. It increases materially the load bearing properties when the material is used as a bearing. A mixture of 20% lead and balance nylon appears particularly interesting for oilless bushings. The presence of a filler, such as lead, also decreases water absorption and, therefore, increases dimensional stability on immersion in water. Fig. 3 shows the effect on dimensional stability of varying percentages of lead when bearings are exposed to boiling water compared with a bearing machined from annealed FM-10001 nylon rod and a bearing composed of 100% sintered nylon powder of the same composition. The measurements taken were on the inside diameter of bushings, 1/2 in. I.D., 3/4 in. O.D. and 1 in. long.

Other materials can be added, such as mold lubricants, to facilitate the pressing operation; these often greatly reduce the tendency of large pieces to crack on sintering. One of the most effective lubricants is Carbowax 6000, which can be prepared for use by hammermilling and passing through an 80-mesh screen.

Sintered vs Conventional Nylon

It is natural to inquire as to how sintered nylon compares with nylon fabricated by conventional techniques. In general, the unfilled sintered product is somewhat comparable in strength to molded material but does not distort as readily under load and is more brittle. Some fillers, such as copper, give improved strength. Arbitrary strength tests on bars 1/4 to 1/2 in. in cross section (loaded across 1/2-in. dimension) are shown below:

	Load in Lb at Failure
Sintered nylon (Nylasint 66)	700
Machined from molded nylon rod (FM10001)	725
90% sintered nylon, 10% copper	875

Izod impact tests show extremely variable results, but in no case has the sintered product been found to have as high a value as molded rod.

A limited amount of work has been done on determining certain of the electrical properties of sintered nylon, both alone and containing fillers. The results obtained at 1 megacycle are shown in Table 2. While there is some improvement over regular FM 10001 nylon and a still greater improvement when fillers are added, the loss factor is in a totally different range from the really good materials such as polyethylene and Teflon; therefore, there seems no likelihood that it will be of unusual value in high frequency electrical applications. The interesting feature of the data is the fact that there is a difference between sintered nylon and extruded nylon. We have also noticed that the sintered material has a different x-ray diffraction pattern, being very similar to that of extruded nylon, which has been subjected to an annealing process. This may, in part, explain the greater dimensional stability of the sintered product, since the x-ray patterns indicate a more stable configuration.

Expansion measurements have been made on mixtures containing from 0 to 80% of graphite, the results being shown in Fig 4. It will be noted that the presence of 40% graphite roughly halves the expansion and 80% graphite reduces it by a factor of approximately ten. Depending on the end use of the material, other fillers could, of course, be substituted for graphite.

Bearing Properties

One of the obvious applications for sintered nylon appears to be bearings. Various tests to determine its suitability for this use have been car-

Table 2—Electrical Properties of Sintered Nylon

Sample	Dielectric Constant		Loss Factor	
	at 30% R.H.	After 24 Hr in Water	at 30% R.H.	After 24 Hr in Water
Extruded Nylon Sheet (Hexamethylene Adipamide)	4.77	5.40	0.163	0.207
Sintered 66 Nylon	2.99	4.26	0.0216	0.115
Sintered Nylon Containing 25% TiO_2	3.83	4.80	0.0172	0.085
Sintered Nylon Containing 25% Teflon	2.89	3.09	0.0132	0.033
Sintered Nylon Containing 25% Finely Powdered Silica	3.23	3.68	0.0140	0.0385

Table 3—Wear Resistance Properties

Sample	Lubrication	Coeff. of Friction	Wear after 210 Hr, (In.)
Sintered Nylon	Continuous oiling	0.049 high 0.018 low	None
Machined from Extruded Nylon Rod	Continuous oiling	0.018 high 0.005 low	None
Injection Molded Nylon	Continuous oiling	0.022 high 0.005 low	None
Sintered Nylon	No oil	0.062 high 0.040 low	None
Machined from Extruded Nylon Rod	No oil	0.289 high 0.009 low	Seized in 1¼ hr
Injection Molded Nylon	No oil	0.334 high 0.156 low	Seized in 2 hr
Same but Clearance Increased to 0.0065	No oil	0.308 high 0.022 low	Seized after 2.5 hr

ried out. These consisted of wear tests both in the laboratory and in actual use, and standard Tabor Abrader tests.

Laboratory wear tests have been carried out at loads varying from 15 to 400 psi with a surface speed of 135 ft per min. For comparative purposes, bearings of other types have been tested under similar conditions. These have included bearings machined from extruded nylon rod, annealed and otherwise, injection molded nylon, and metal powder bearings. In these series of tests the nylon bearings were cemented in brass retainers since press fits due to the cold flow of nylon cause distortion with a consequent loosening of the bearing in the retainer and a reduction in clearance between shaft and bearing. Several adhesives were tried for this purpose, the most satisfactory being Pliobond (Goodyear).

Table 3 shows typical data obtained from sintered and injection molded FM 10001 nylon. The data were obtained from tests on bearings ½ in. I.D. and ½ in. long, mounted in brass retainers and fitted to a ½ in. shaft, the clearance being 0.003 in. The shaft surface speed was 136 ft per min and the loading 200 psi.

It will be noted that no significant wear took place in any of the tests. Also, when oil is present, the friction coefficient of the injection molded bearing and the machined bearings is lower than that of the sintered material. However, when oiling was discontinued, the friction coefficient of the injection molded and machined bearings rose rapidly to a high value and the bearings seized after a short period of operation. In the case of the injection molded bearing, increasing the clearance to 0.0065 in. did not enable it to run without oil.

It might be argued that the sintered material, possibly being porous, functioned in the test somewhat like an oilless bearing. However, unoiled bearings sintered in vacuum and bearings sintered in oil which have been subsequently machined to remove any oil penetration have been operated satisfactorily for long periods.

Exhaustive tests have been carried out to determine the preferred oiling procedure. Bearings have been run with (1) continuous oiling, (2) oiling at the start only, (3) after being saturated with oil, and (4) without oil. Here again it has not been possible to show any significant wear with light loads under any of these conditions. In one test using a load of 76 psi, a bearing was still in operation after 1000 hr without oil.

While as indicated, sintered nylon shows greater dimensional stability than that fabricated by conventional techniques, it appears that this property is further improved by an annealing operation which involves holding the specimen at 212 F for approximately 12 hr. Even with sintered material so stabilized, it appears advisable to allow a bearing clearance of at least 0.006 in. per in. of shaft diameter for loads of the order of 75 psi. At higher loads when greater heat is developed, we believe more clearance must be provided, although further work is required to permit exact specifications to be laid down.

Tabor Abrader tests have been carried out on sintered 66 nylon in comparison with FM10001 extruded strip with the results shown below:

	Wt. Loss per 1000 Rev.	
No. of Revs.	*Extruded Strip*	*Sintered*
3,000	0.0312	0.0146
4,000	0.0206	0.0149
5,000	0.0090	0.0134
6,000	0.0090	....

While initially extruded strip wears away more rapidly, when a stable condition is reached, the sintered product appears to have slightly poorer abrasion resistance.

A number of very interesting shop and field tests of sintered nylon bearings have been made to test the material under conditions simulating actual operation. In one of the most significant tests, a prominent manufacturer of motor generators tried out the new type of bushings on brush holders. To accentuate the pounding involved, a laboratory device was devised whereby the brush holders were run against a circular cam having four ⅛-in. high projections around the circumference. Six sintered nylon bearings and six metal powder bearings were tested. After 200 continuous hours of test, all the metal bearings had failed. The sintered nylon bushings (0.272-in. I.D. by ⅜-in. O.D. by 0.640-in. long) were still in excellent condition after 500 hr of operation (132,000-000 actuations).

In another instance a bearing made from powdered nylon was substituted for a porous bronze bushing in a standard make electric fan. This fan has been running continuously

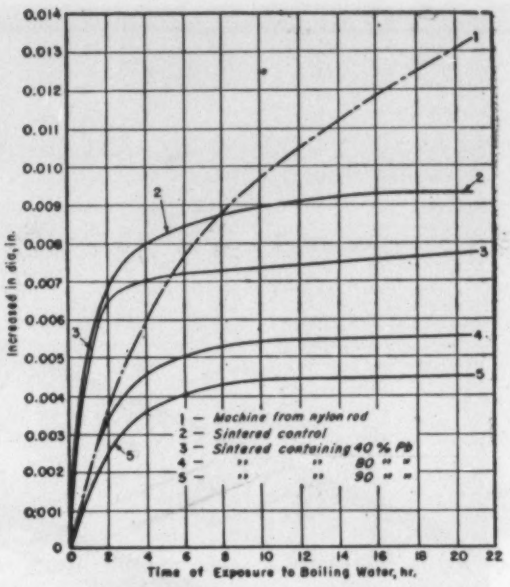


Fig 3—Effect of boiling water on dimensional stability of bearings made from machined nylon rod, sintered nylon, and sintered nylon containing varying percentages of lead.

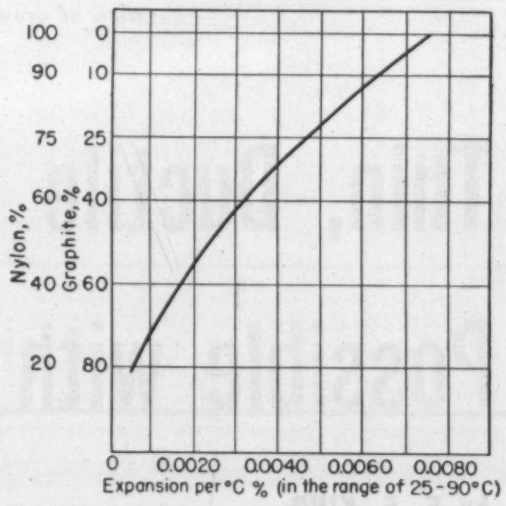
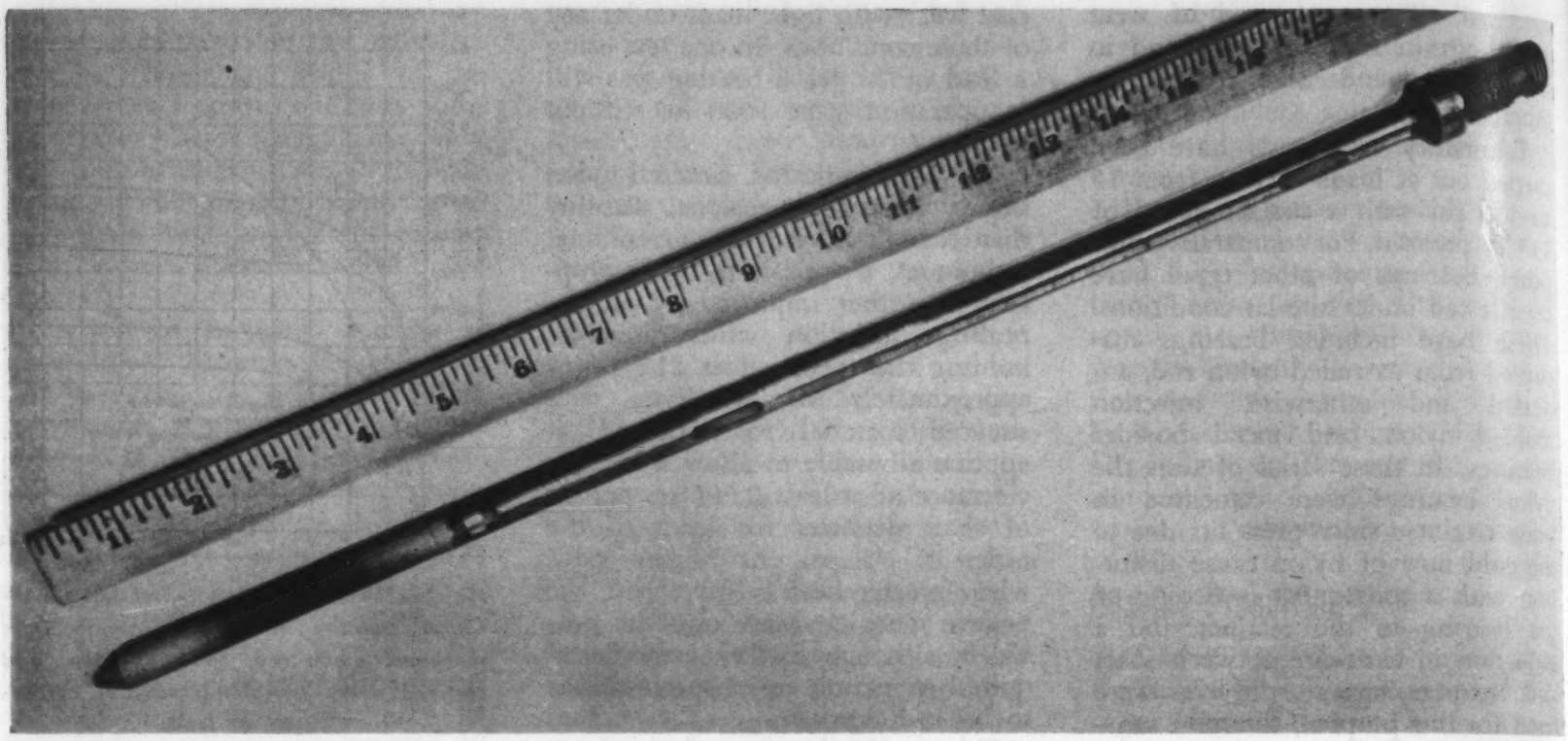


Fig 4—Expansion of sintered nylon and of graphite.

day and night for 120 days without lubrication, and is reported to be showing no trouble of any kind.

Although this new technique of processing nylon appears to lend itself particularly to the field of bearings, preliminary investigation indicates it will also be useful for other parts requiring wear resistance, such as oil seals, lightly loaded silent gears, cams, rollers, thrust washers, etc. In addition, the possibility of incorporating special fillers, such as diamond dust, with the nylon suggests uses in lapping and other abrasive tools. It is further possible that the addition of high percentages of electrically conducting powders, such as copper to nylon, may offer certain special advantages in sliding contacts. It is, therefore, apparent that the advent of sinterable nylon powder should further broaden the industrial possibilities for this remarkable synthetic material.



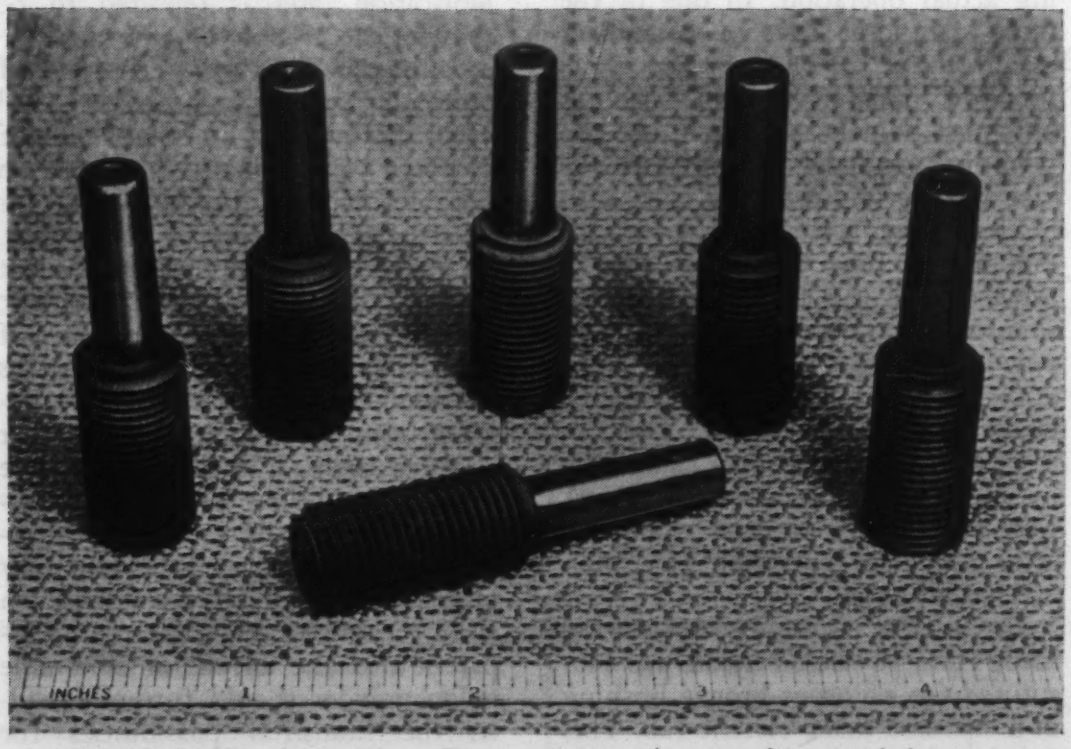
CORE RODS used in powder metallurgy must resist severe abrasion and be tough enough to withstand some deformation. This combination of properties can be met by Flame-Plating tungsten carbide on a steel base.

Thin, Ductile Carbide Coatings

Possible with New Method

by F. E. KING,

Assistant Superintendent, Speedway Laboratories, Linde Air Products Co.



THREAD GAGES after coating. These parts must be ground to size before use.

. . . Practically all common metals can be Flame-Plated with minimum distortion.

. . . Tungsten carbides and other high melting point materials can be deposited.

● FLAME-PLATING is a new method of coating metal parts with a very thin layer of extremely hard materials. Although the surfacing of metal parts with hard materials to protect them from wear is not new and hard facing, electroplating, fusion-welding and metallizing are some of the methods by which this objective is accomplished, Flame-Plating is a different process. It is the only known method of depositing tungsten carbide in the form of a thin coating that is not diluted by base metal or welding rod. This coating is hard, but it also has other desirable properties not usually associated with hard materials. It has more ductility than would be expected of a material having a hard-

ness of about Rockwell A89 while, at the same time, shows wear resistance superior to the sintered tungsten carbides. The process is also adaptable to the deposition of other high melting point materials on various base metals.

Coating Properties

The exact procedure used in Flame-Plating cannot be revealed at present, but powdered tungsten carbide is deposited in the form of a coating, and can be applied in thicknesses ranging from 0.0005 to 0.020 in. The particles forming the coating are elongated and flattened into thin disks, which are bonded mechanically to the base metal. There is no welding between the two materials and, therefore, no interdiffusion. Thus, the properties of both base metal and coating are retained.

One of the major advantages is that the temperature of the base metal does not exceed 400 F during the plating operation, even when tungsten carbide is being deposited. The low temperature deposition reduces to a minimum the possibility of a change in the properties of the metal being plated, or the tendency of the part to warp.

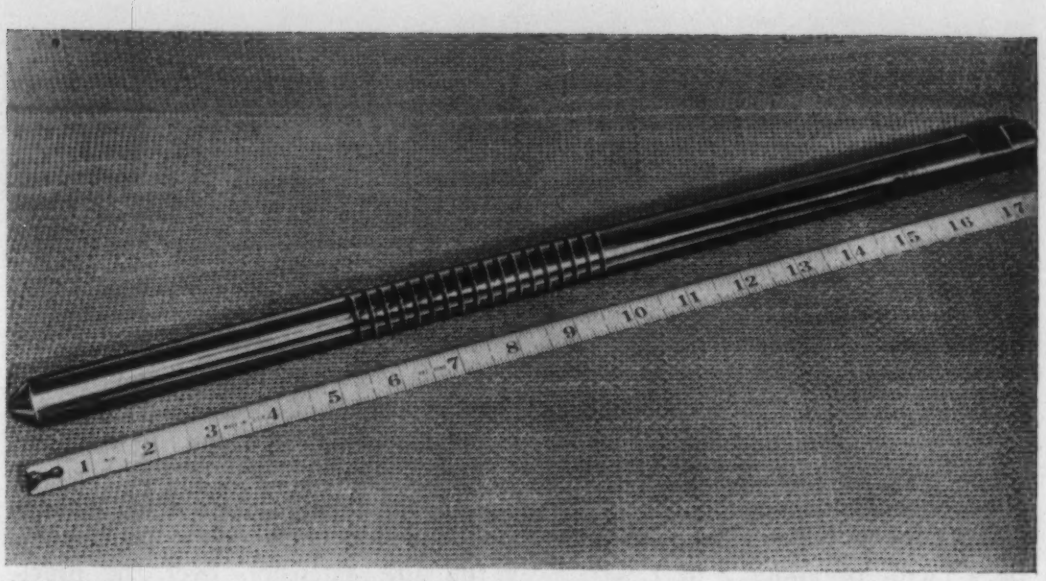
Flat areas, cylinders, holes and parts having various shapes and contours can be coated. Surfaces up to 6 in. wide and 40 in. long can be handled with present equipment. As deposited, the surface finish is 125 microinches, rms. For some applications this finish is satisfactory. For others, the surface can be ground and polished to a finish of about 2 microinches, rms, if desired, using resinoid bonded diamond wheels.

Practically all commercial metals can be coated satisfactorily, but the bond is stronger on soft metals, such as aluminum, than it is on extremely hard materials like chromium.

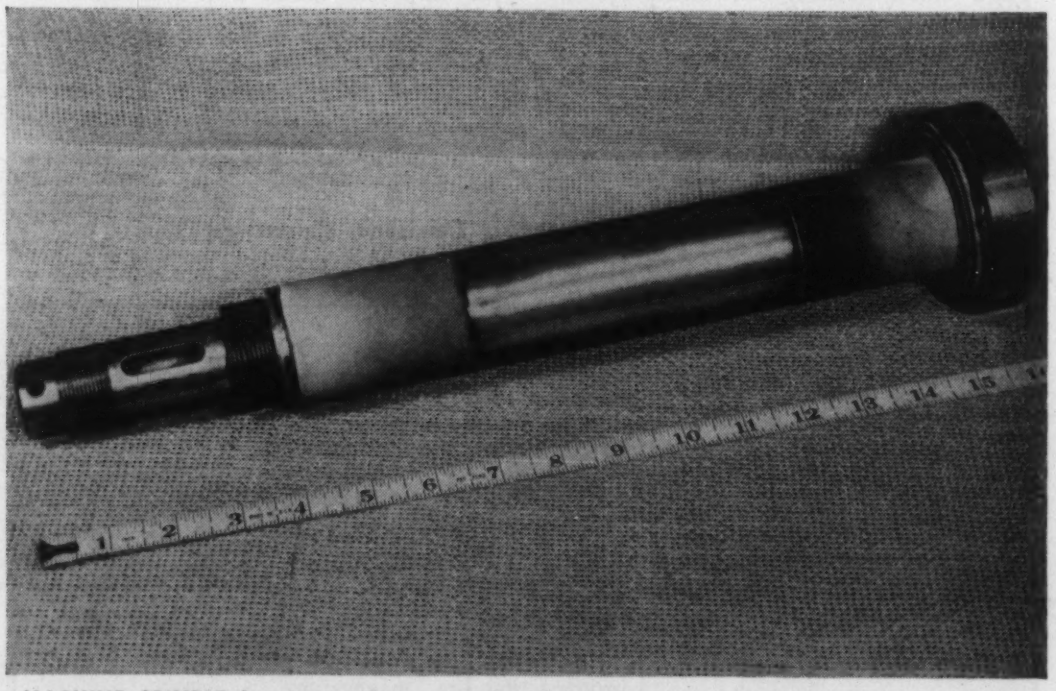
Applications

The applications of Flame-Plated tungsten carbide parts are still being investigated. However, a number of interesting uses have been developed.

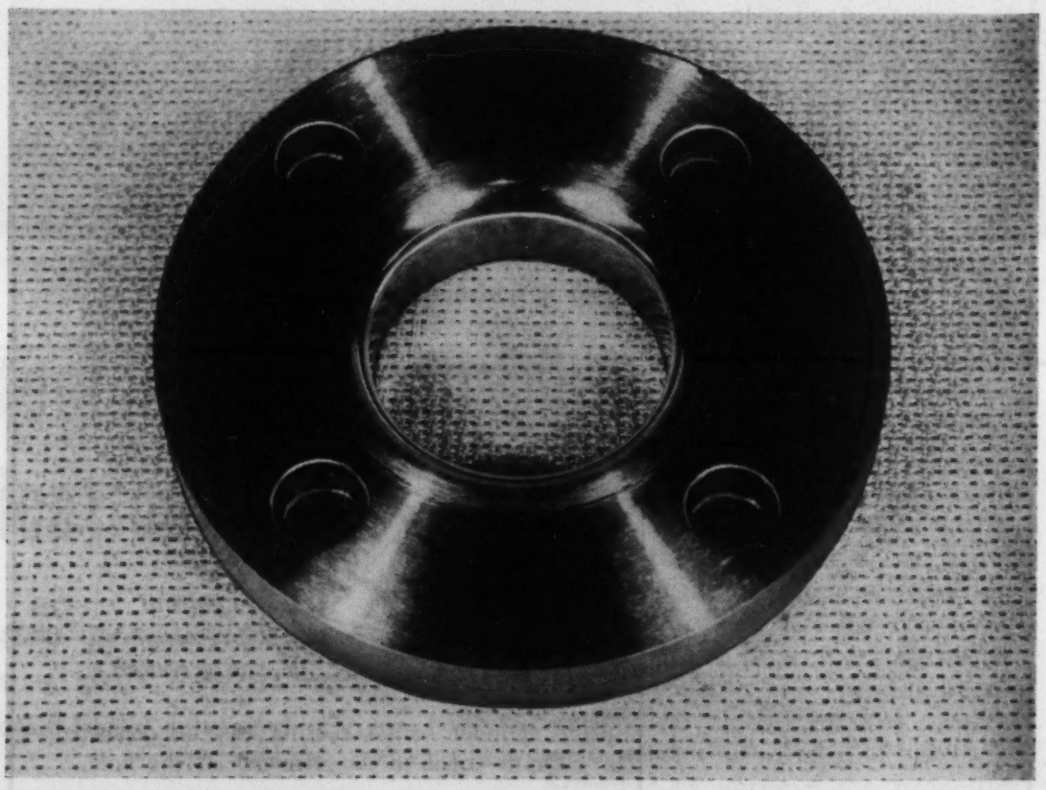
In the manufacture of powdered metal parts, the material used is compacted in a die shaped to the contour of the finished part. If this part, such as a powdered metal bearing or gear, has a hole molded in it, a supplemental die part known as a core rod is used to mold the hole. In a great many cases, core



***BURNISHER** cutting areas coated by the new process retain their dimensional accuracy for thousands of operations.*



***MACHINE SPINDLE** bearing surfaces can be Flame-Plated for improved wear resistance. After coating, the part requires grinding to obtain the necessary finish.*



***CUP-DRAWING DIES** Flame-Plated on inner lip to increase the wear resistance. For such application, a 0.003-in. coating is used.*

rods are round, long and slender. While it is often convenient and economical to use sintered tungsten carbide for other die parts, the core rod is usually made of steel because of the brittleness and frequent breakage of sintered carbide in this application. Powdered metal parts are made in huge quantities and at high rates of speed so that core rods of steel frequently wear out in a period of days. Flame-Plated tungsten carbide core rods last 15 to 20 times longer than chromium-plated steel core rods, with chromium-plating being better than plain steel by a factor of about 2 to 1.

Another application is the plug gage used widely in industry. It has been fairly well established that Flame-Plated plug gages outwear sintered carbide gages by a factor of 2 or 3 to 1. It is common when making sintered carbide gages larger than about 1 in. in dia to use them in the form of bushings attached in various ways to a steel support. The increase in life of Flame-Plated gages when compared with carbide bushings is even greater than when compared with solid carbide gages. In comparison with more commonly used gage materials, such as the better grades of tool steel, the life factor is extended to such a degree that even though the steel gage is much cheaper, the cost of a Flame-Plated gage is lower, per part gaged.

A third application is the coating of burnishing broaches. Here again the life extension over the previously used chromium-plated broach is approximately 20, although the cost of a single broach is increased only four times.

These three examples are applications in the machine tool or manufacturing industry. Other applications are related to the use of the coating directly on parts that go into machines purchased by the consumer. Typical is a valve lifter or tappet in an internal combustion engine. The advent of higher compression ratios, higher explosion pressures, and overhead valves with the increase in inertia loads of the extra parts, has placed an increasing load on the valve tappet which rides the cam of the cam shaft. As a result, manufacturers are searching for an economical means of increasing the wear life of the face of the tappet which is in contact with the cam. Tappets with Flame-Plated coatings have passed preliminary laboratory investigations and are being run in engines for further appraisal.

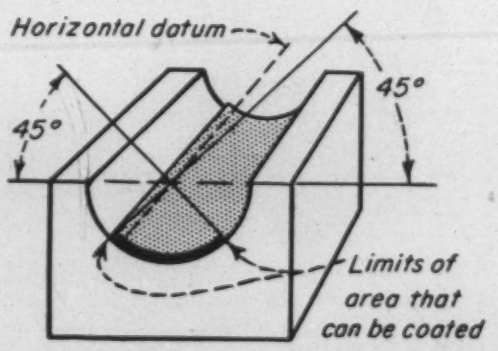
In a number of other applications, Flame-Plated parts have shown improved performance over the steel parts normally used. A Flame-Plated deep drawing die was used to produce 23,000 steel cylinders without showing appreciable wear, while the normal production for a steel die averaged 5000 to 8000 parts. The life of paper slitting knife blades has been more than doubled by Flame-Plating.

In all the applications discussed so far, the Flame-Plated material has been ground after coating to obtain a precise dimension and smooth surface. There is a field of application, however, where the coating, which is relatively smooth in the "as-applied" condition, can be used directly without further finishing. A typical example of such an application is the coating of spindles for cotton picking machines. The small barbs on these spindles, which are rotated at 2000 rpm and pick the cotton from plants in the field, become dull in a relatively short time because of abrasion by sand in the cotton boll. These spindles are fairly expensive and large numbers are used on each machine. By the application of a 0.0005- to 0.001-in. coating, laboratory tests indicated a sufficient increase in life to more than justify the cost of the coating.

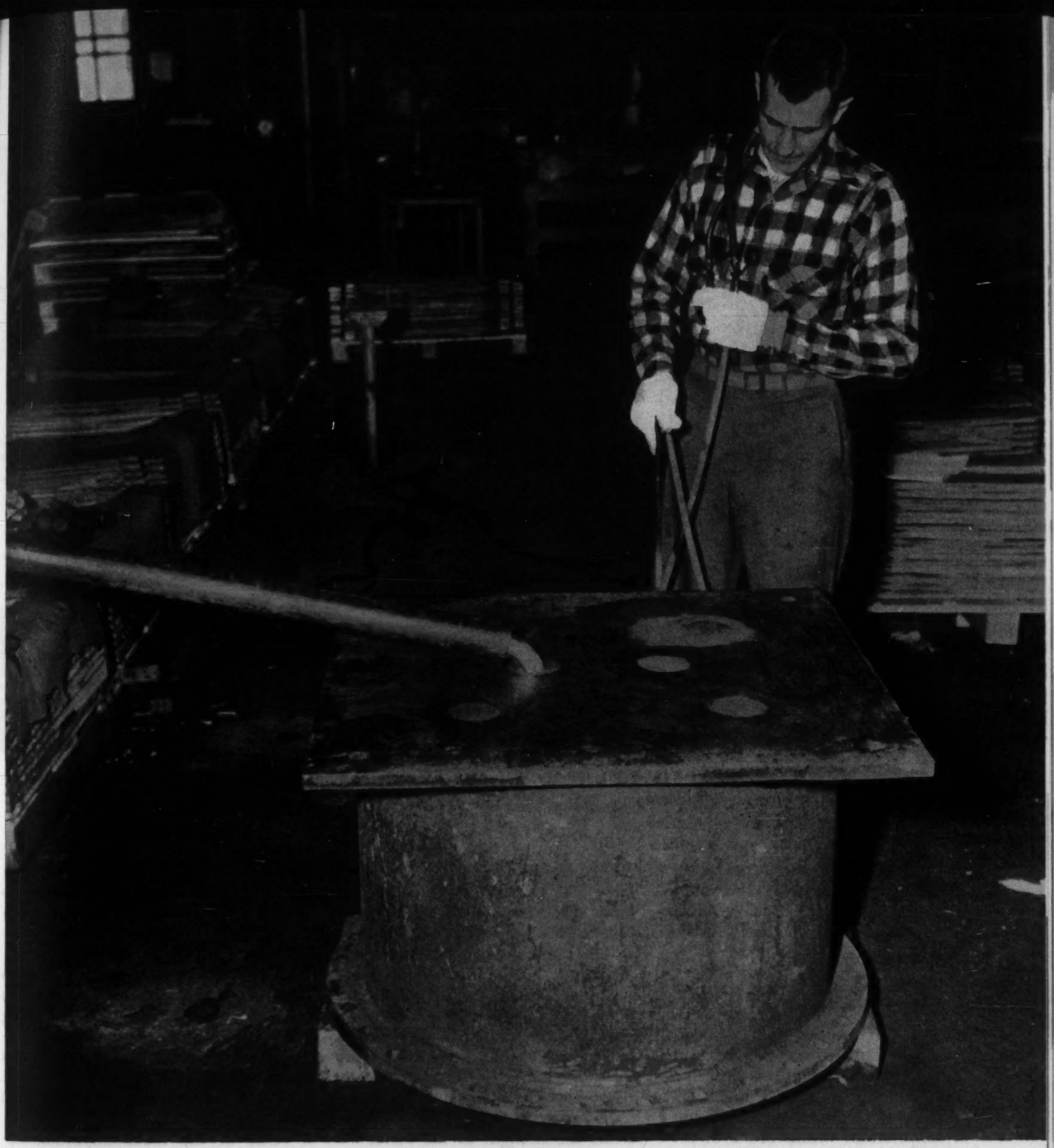
This use is still under appraisal, but part of the spindles on one cotton-picking machine have been coated and the machine is currently in field operation. Another example is a circular saw used in lumber mills. A Flame-Plated saw operates several times as long as the steel saw used previously.

Flame-Plated Tungsten Carbide Coatings

(Currently Being Applied)

Composition	92 tungsten carbide 8% cobalt
Hardness	1200 to 1500 Vickers (300 gm. load)
Coating Thickness	0.020 in. max; 0.0005 in. min
Surface (As Coated)	125 microinches rms (Brush Analyzer)
Surface (After Finishing)	2 Microinches rms (Brush Analyzer)
Base Materials	Tool steels, cast iron, aluminum, copper, brass, bronze, titanium, magnesium
Temperature of Base Piece during Application of Coating	Less than 400 F
***Size of Base Piece**	*Round*: O.D.—from 1/8 in. to 6.0 in.; Length—to 40 in. *Flat*: As coated—6 in. by 40 in.; Finish-ground—3/4 in. by 40 in.
***Shape of Base Piece**	Externally—any area at no greater than 45 deg from a horizontal datum  Inside cylinder walls—coating can be deposited to a depth equal to the diameter of the hole.

** Other sizes and shapes can be handled with special jigs and fixtures.*



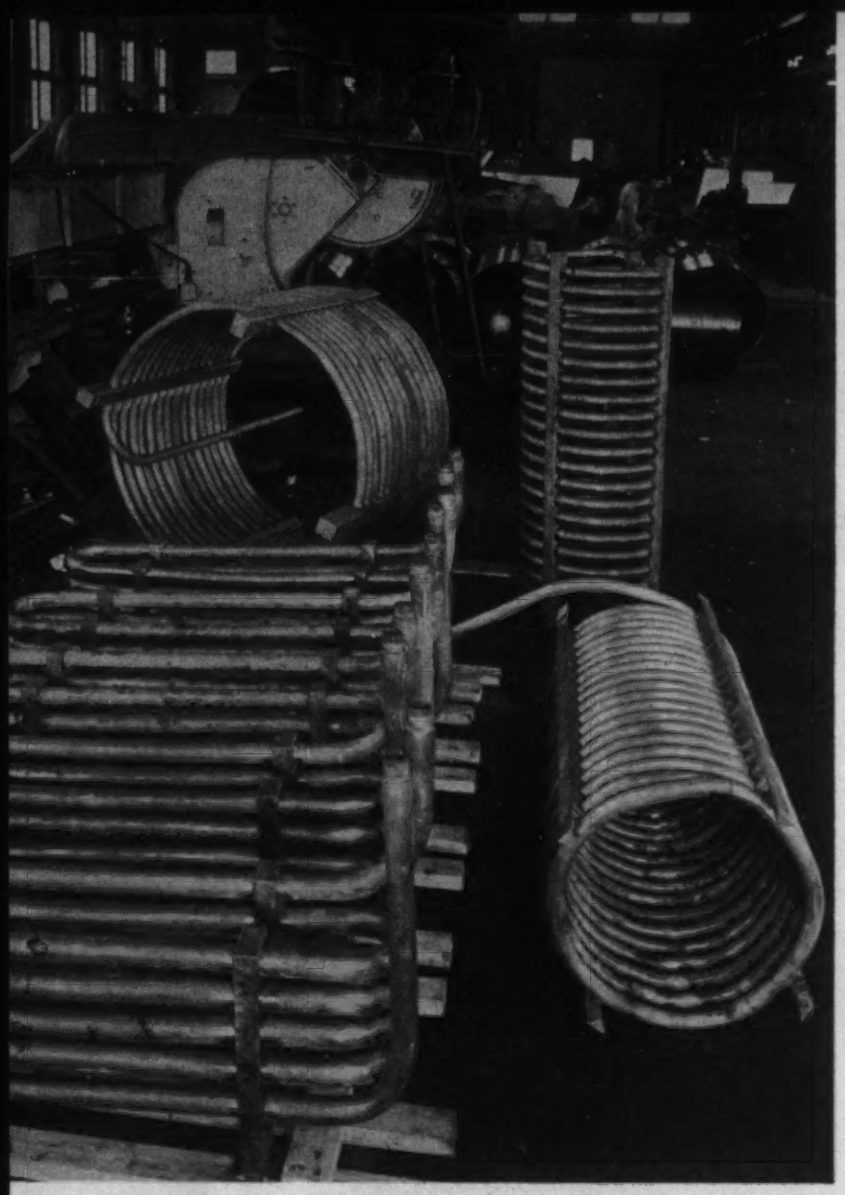
Steel shell being lead-lined by the pouring process.

How Lead-Clad Steel and Copper Extend Lead Applications

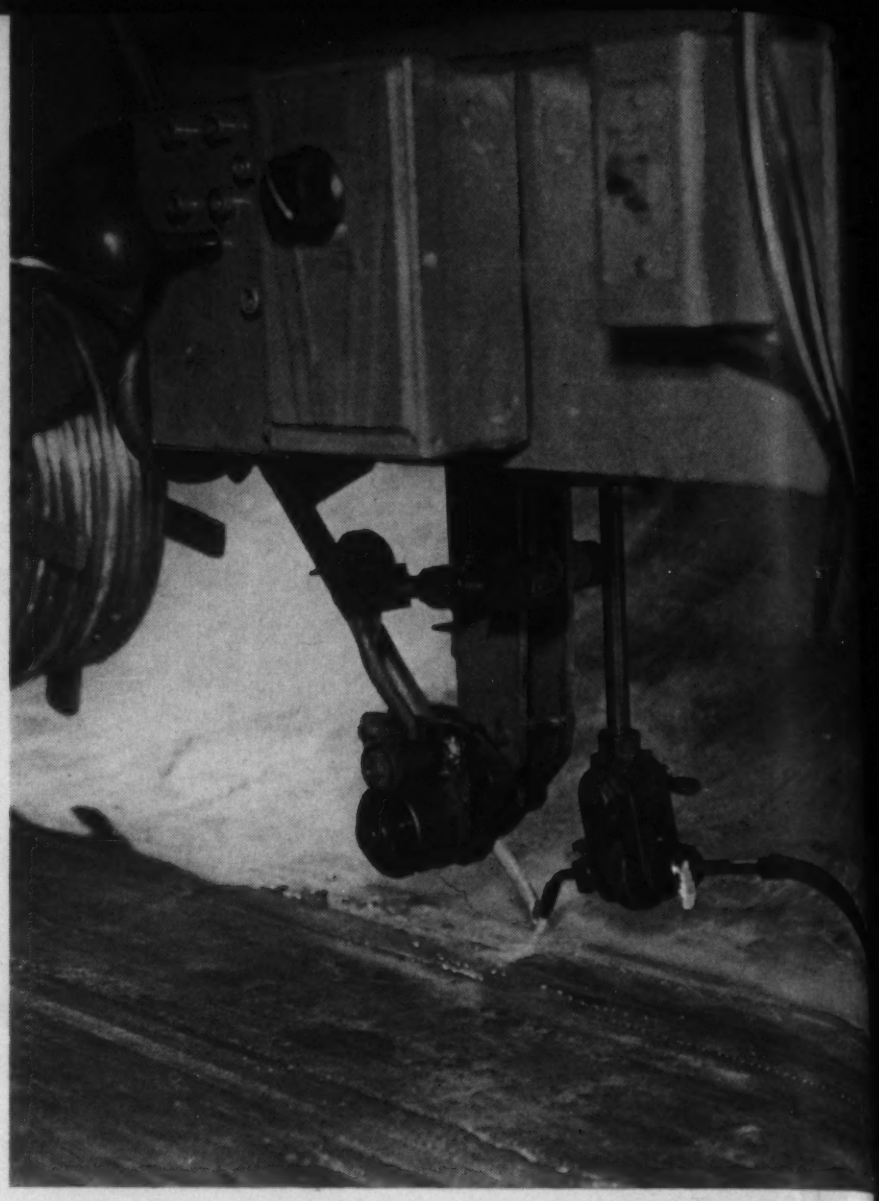
By combining strength, electrical properties and excellent corrosion resistance, these clad metals overcome many disadvantages met when lead is used alone.

by ALFRED P. KNAPP, President, Knapp Mills, Inc.

● THE RESISTANCE OF lead to corrosion, particularly by sulfuric acid, has made it an important constructional material for the chemical industries. However, lead has certain disadvantages which limit its usefulness. It has low strength and is not very resistant to vibration, and fatigue failures occur rather frequently in the presence of temperature cycles. It is unsuitable for vacuum operations unless the thickness is so great as to make the vessel uneconomical. Attempts to improve the properties of lead by alloying have not yielded completely satisfactory results, par-



Because of superior strength and conductivity, lead-clad copper coils are replacing lead coils in the chemical industry for the handling of sulfuric acid.



Lead "burning" with this machine which was developed recently produces a lead coating of uniform thickness and density.

ticularly for some of the newer chemical processes which require materials to withstand elevated temperatures, or vacuum operations which may be subjected to vibration.

To overcome these disadvantages, methods of bonding lead to steel were devised. This new clad metal is called Ferrolum. The product combines the corrosion resistance of lead with the strength of steel and was found to withstand high vacuums under vibrational conditions at temperatures within 100 F of the melting point of lead. Further, lead-clad steel resisted temperature changes much better than lead because the lead cladding expanded and contracted with the steel and was continuously supported. The procedure was applicable to the lining of tanks, pipes, valves and fittings and to covering steel pipe, copper tubing and other metals. Lead-clad copper is called Cupralum.

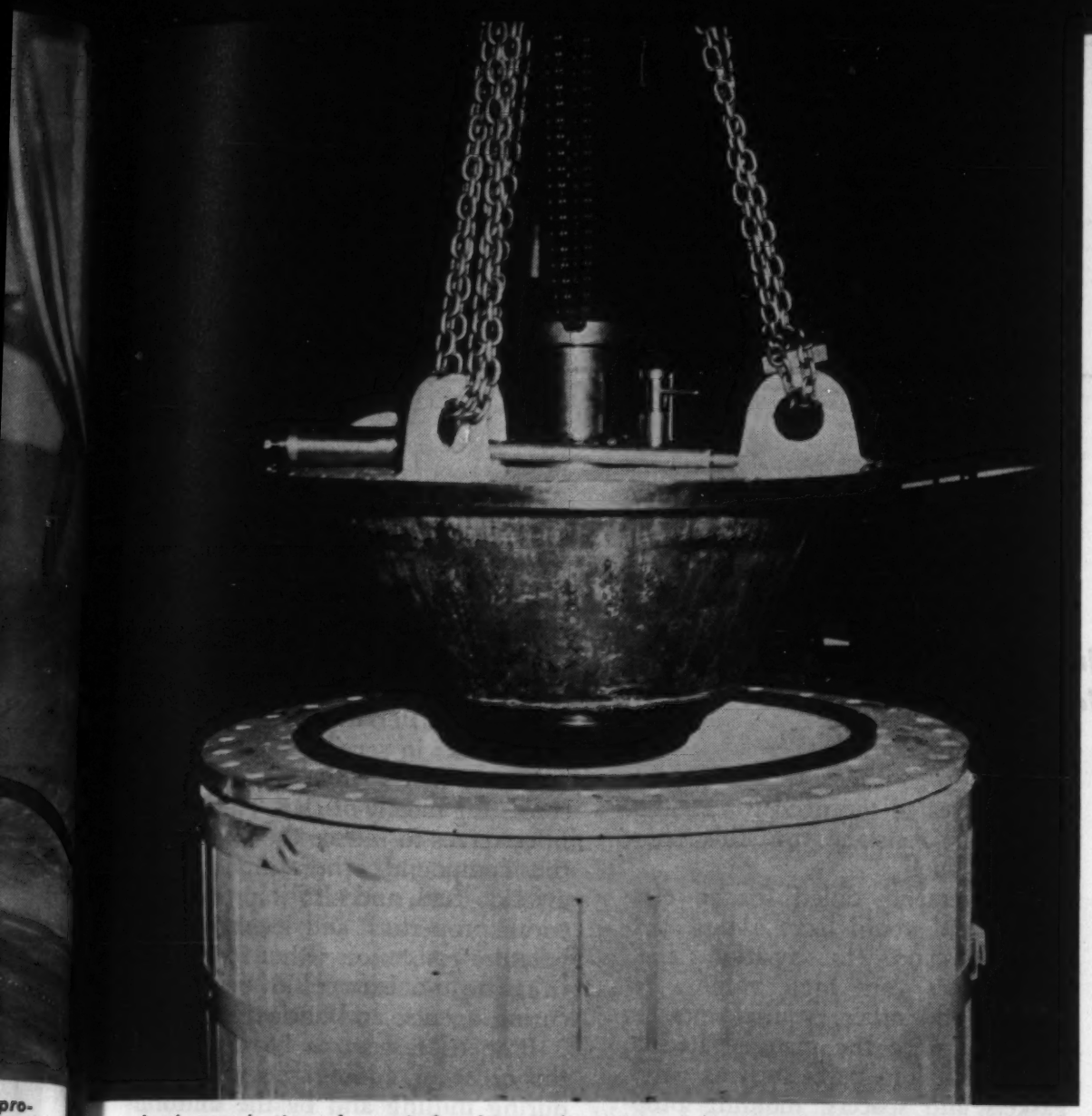
Although some lead-clad steel is produced by hand methods, lead "burning" requires a high degree of skill, and experienced workmen are needed to produce a satisfactory clad surface. Thus, the product obtained is expensive. In recent years, a method devised in Germany, which is known as the pouring process, has been introduced in this country. In this process the steel surface is pickled to remove oxides, cleaned and molten lead is poured on the surface to be clad. Alternately, for the lining of pipes, slightly undersize lead tubing is placed in the cleaned pipe and heated and expanded with steam pressure to form the bond. After cladding, the composite material can be rolled or drawn to increase the strength of the bond.

Applications

Most of the present applications of lead-clad steel and copper are based on the corrosion resistance of the lead. Thus, one of the first applications was the replacement of sheet lead which has been used for many years in the lining of equipment for the handling of corrosive chemicals. Such linings were usually strapped into the steel shell and held in place mechanically. The method was useful in the handling of cold solutions but the life of the lining was short under conditions of fluctuating temperatures or vibration. Maintenance costs were high. Lead-clad steel equipment is replacing such linings, particularly for applications involving elevated temperatures or vacuum processes.

Lead-clad steel has been used also for coil legs, frames and hangers in heat transfer applications involving corrosive solutions to provide rigidity and strengthen the coils and thus overcome the disadvantages of the lead legs frequently used for this purpose.

One of the more important applications of lead pipe has been the fabrication of heating and cooling coils for chemical processes. Because of the low strength of the metal, it must be supported adequately, and it cannot withstand more than about 50 psi pressure in practical wall thicknesses. When heavy wall thicknesses are required, the heating or cooling cycles are increased because of the low conductivity of the lead. On the other hand, lead-clad copper can withstand pressures up to 200 psi. The thickness of the lead cladding can be held to the minimum necessary to protect the copper from corrosion and the combined thickness of the lead coating and the



In the production of a unit for deep radium therapy completed recently, accurate location of a group of radium capsules to permit focusing on a spot was required. Lead-clad steel, combining the dimensional accuracy of steel with the protection afforded by lead, solved the problem.

copper tubing to less than the wall thickness required if lead pipe is used. Thus, a smaller heating or cooling area is required if lead-clad copper is employed or conversely, if the same area is used, the lead-clad copper tubing will reduce the heating or cooling time required. The advantages of lead-clad copper are leading to the replacement of lead pipe with this material in many chemical plant installations.

In the formation of various anodized surfaces on aluminum, it is essential to maintain a constant temperature. Depending on the requirements of the coating, the temperature of the electrolyte must be held at certain fixed levels, in some cases as high as 82 F, in others as low as 25 F. This presents a difficult problem because high temperatures are generated, first in the mixing of the acid, and second, during anodizing through the introduction of heavy charges of electricity into the electrolyte.

Before the introduction of lead-coated copper, lead or antimonial lead coils were considered the best means of cooling the anodizing bath, the cooling medium being water or brine. The strength and rigidity of lead-clad copper, its ability to withstand higher pressures than unsupported lead, its high thermal conductivity and its resistance to fatigue have made possible improvements in cooling practice, such as, for example, the employment of low temperature coolants in place of water.

In the Alcoa hard coat process, it is necessary to keep the electrolyte cooled to 50 F and sometimes to 25 F for long periods of time. Because of the high current density requirements of the process, adequate cooling is essential. In a certain installation, calculations of heat transfer, water and solution temperatures and Btu input showed that the lead cooling coil area required would leave little tank space for the work since 480 lineal ft of lead pipe would be required. Similar calculations based on the use of lead-coated copper with Freon as coolant showed that only 180 lineal ft of 1⅜-in. copper tubing with 3/16-in. lead cladding would be needed. As a result, practically the entire tank area was available for work space.

An installation using Cupralum lead-coated copper tubes and Freon 12 as coolant has been in service for a sufficient period to show that it can successfully meet one of the troublesome phenomena of refrigeration, the fact that cooling results obtained during the early stages of operation are sometimes startlingly better than those attained later. This installation consistently holds the electrolyte at 25 F for any required period of time.

Cupralum lead-coated copper anodes have been used in chromium plating installations with distinct advantages over the lead and antimonial lead anodes previously employed. The former have been found to carry up to ten times the amperage of comparable lead anodes and to distribute current of uniform density over the entire anode area. Because of the uniform current distribution, longer life is obtained. In an installation where ribbed antimonial lead anodes were replaced at six-month intervals, lead-clad copper anodes are still in service after 12 months. Uniform current distribution aids the plater also in reducing excessive deposits, burned areas, and high spots.

Another application is based on the fact that lead is widely used for protection from the harmful radiation encountered in the operation of x-ray equipment, in nuclear fission, and in the handling of radium. Lead-clad steel is excellent for the fabrication of shields for radioactive materials because it is strong, can be machined and can be clad with any thickness of lead necessary. The properties of this material were utilized in the fabrication of a unit for deep radium therapy which has been completed recently. The radiation from two grams of radium is not harmful to normal tissue but is also of too low an intensity to destroy cancerous growths. Therefore, a machine was developed in which a group of 25 two-gram units of radium were placed in such a fashion that the entire energy output could be focused on a spot. Thus, the radiation could be passed through the skin in harmless doses and focused to apply the entire energy from the group of radium capsules on the diseased tissue. This apparatus required accurate location of the radium units and accurate focusing, a difficult job to be done with a material as soft as lead. By the use of steel clad with ⅜-in. of lead, the advantages of the dimensional accuracy possible with steel with the protection afforded by lead were obtained.

Two New

A Gasoline Resistant Elastomer

Meets rigid aircraft requirements and can be readily molded.

Synthetic rubbers of certain types have shown outstanding superiority to natural rubber in resistance to oil. The Neoprenes and the nitrile types are commonly used for hoses to carry petroleum oils and gasolines, and perform successfully in an application for which natural rubber would be completely unsatisfactory. However, the development of high-octane aviation fuels, containing considerable amounts of aromatic hydrocarbons in addition to the straight-chain petroleum distillates, created the need for another elastomer resistant to this new blended fuel.

Requirements called for an elastomer that would have almost perfect resistance to aviation fuel, along with very high volume resistivity and other requirements. In addition, since the material had to be molded into parts such as rings, gaskets and spacers, molding properties had to be maintained.

The Plastics Laboratory of the Minneapolis-Honeywell Regulator Co. investigated formulations based upon nitrile type synthetic rubbers, because they had the proper chemical resistance combined with electrical properties. After about a year of experimentation, they developed a mineral-filled material that gave satisfactory results in service.

The mineral filler is a mixture consisting mostly of clay. The mineral filler serves to reduce the swelling of the compound when immersed in aviation fuel, and also improves electrical properties and elevated temperature resistance. Other ingredients include nonextractible plasticizers, curing agents, and antioxidants.

Properties seem to be affected by the order of adding the ingredients during milling and by the uniformity and thoroughness of dispersion. Parts are then molded by transfer molding.

The tests applied to the finished pieces are severe. Samples are placed in a steel cylinder with aviation fuel (ASTM—SR6), and are held at 165 F for one week. Swell at the end of this test period must be no more than 25%. Actual swell in the molded pieces is less than 18%. After drying for another week, the sample must not have shrunk more than 5% from the original dimensions. Dielectric strength is determined both before and after soaking, and at room temperature and at 160 F.

Some typical properties of the new rubber are as follows:

Tensile strength approx.	1700 psi
Elongation at rupture	275%
Durometer "A"	70 plus 5 or —10
Dielectric constant, at room temp.	12.0
Dielectric constant, at 160 F.	11.5
Volume, resistivity, at room temp.	1×10^{12} ohm cm
Volume, resistivity, at 160 F.	0.1×10^{11} ohm cm
Power factor, at room temp.	1.4%
Power factor, at 160 F.	6%

The rubber can be bonded to metal with the usual rubber phenolic adhesives. Excellent bonds are obtained without difficulty.

A mineral filler, mostly clay, reduces swelling of new synthetic rubber when placed in gasoline, and improves electrical and high temperature properties.

New Synthetic Rubbers—

A High Strength Silicone

Tensile and elongation properties about double those of other silicones.

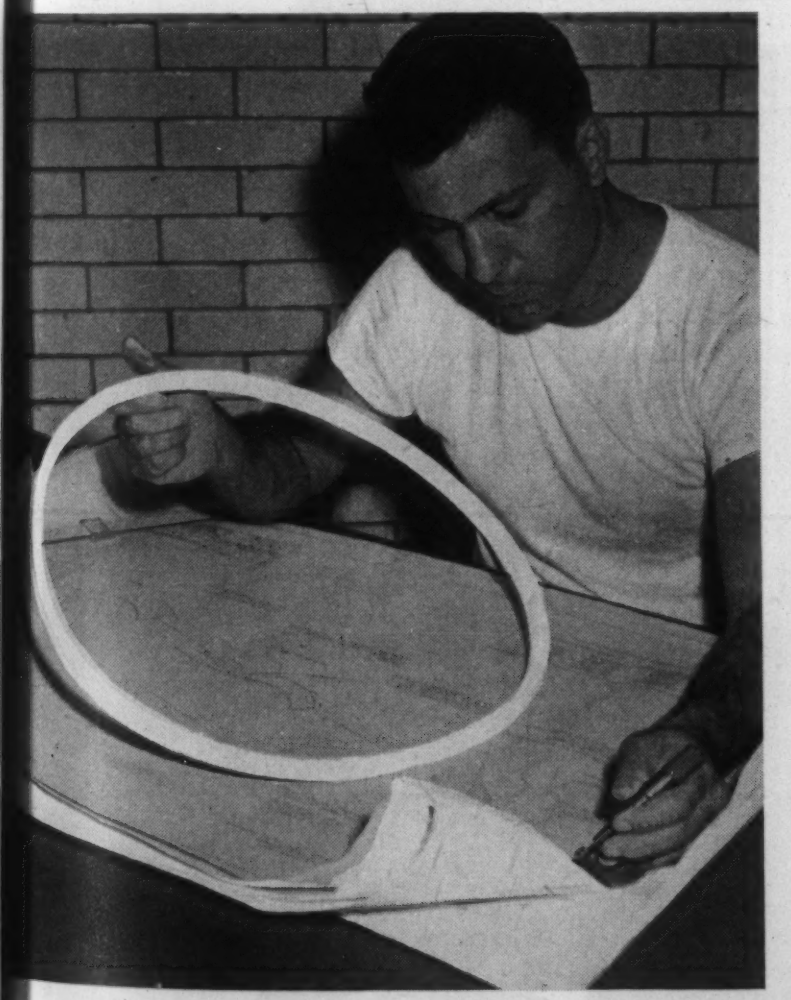
● THE ABILITY OF silicone rubbers to withstand extremes of temperature, ranging from —100 to +400 F, has gained for them many important applications. However, their usefulness has been limited to rather poor tensile strength and elongation. Now, through a new development of Connecticut Hard Rubber Co., these barriers to many applications seem to have been lifted.

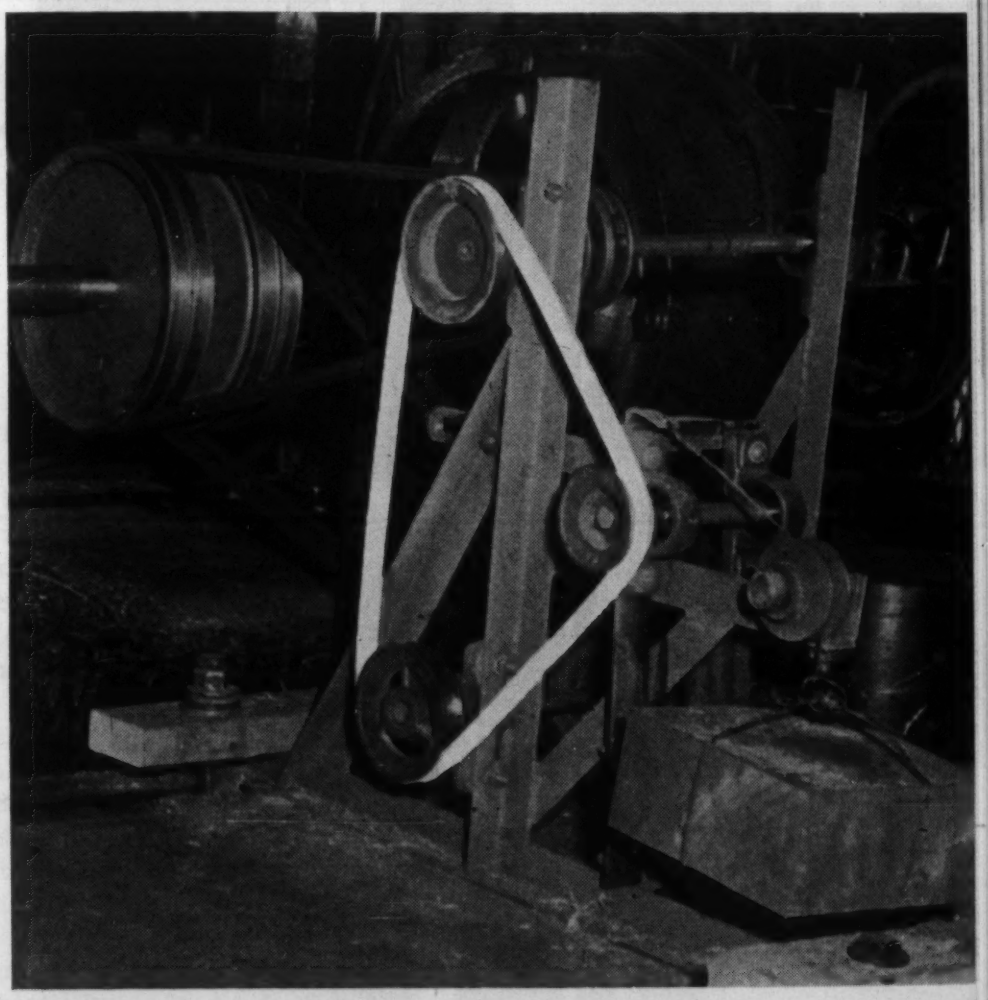
New Cohrlastic silicone rubber, first publicly announced on July 1 of this year, makes silicone rubber competitive, from the standpoint of properties, with natural and synthetic rubbers. The new silicone rubbers have tensile and elongation properties approximately double the best comparable properties claimed for any currently offered silicone rubbers. The new product came about as a result of a research project carried out for the Office of the Quartermaster General, U. S. Army.

Achievement of the new properties is credited largely to new compounding techniques involving ultra-fine silica pigments. The use of silica in this application is likened to the use of carbon-black in butadiene copolymer rubbers to attain high strength and elasticity. Even greater strengths can be anticipated if the silica particle size can be reduced further. Presently, the ultimate particle size of the pigment is in the range of 0.01 micron.

Currently, the best properties claimed for silicone rubbers show optimum tensile strengths to range between 400 to 1000 psi, with elongations in the 40 to 600% range. The new compounds provide tensile strengths from 1000 to 2000 psi and elongation of from 200 to 800%. The increase in tensile strength and elongation also has resulted in vastly improved abrasion

Excellent strength and elasticity properties suit new silicone rubber for such uses as V-belts. Silicone rubber V-belt is on test stand at right.





Optimum Properties of Silicone Rubbers

Compound	Volumes, per 100 Rubber	Ten Str, Psi	Elong, %	Hardness, Shore A
GS 199S in SE-76	20	1900	625	68
Alon in SE-76	15	934	1233	33
Hi-Sil in SE-76	20	579	242	50
Santocel CS in SE-76	20	887	308	61

Tests made with optimum curing and optimum filler loading conditions for each pigment.

and tear resistance in the new compounds. An accompanying table shows how the new compound (GS1995) compares with the optimum properties of other silicone rubbers cured for optimum strength.

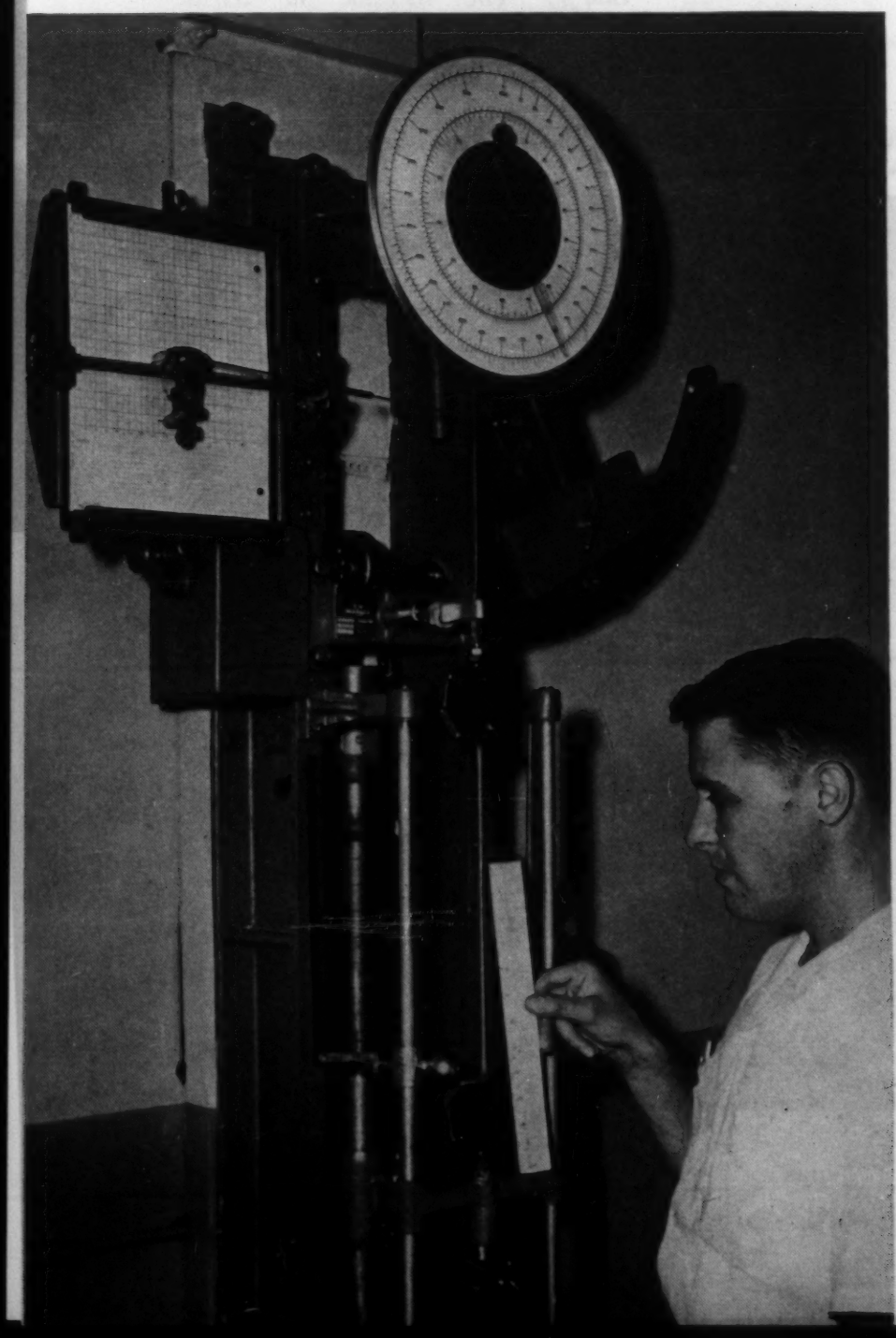
Higher strength properties in the new silicone rubber are achieved without sacrifice of the properties for which such rubbers are noted. Thus, it can be said that the new materials offer the broad range of temperature serviceability characteristics, compression set resistance, resistance to ozone and moderate resistance to oils, lubricants and hydraulic fluids that are provided in the commercially available compounds now in use.

The new compounds have been used experimentally in making automobile tires and V-belts. While it is not expected that the materials will be used for making tires commercially, testing them in that type of application provided excellent proof of their properties. Tread wear tests on the road showed the silicone tread to be comparable to other hydrocarbon rubber treads.

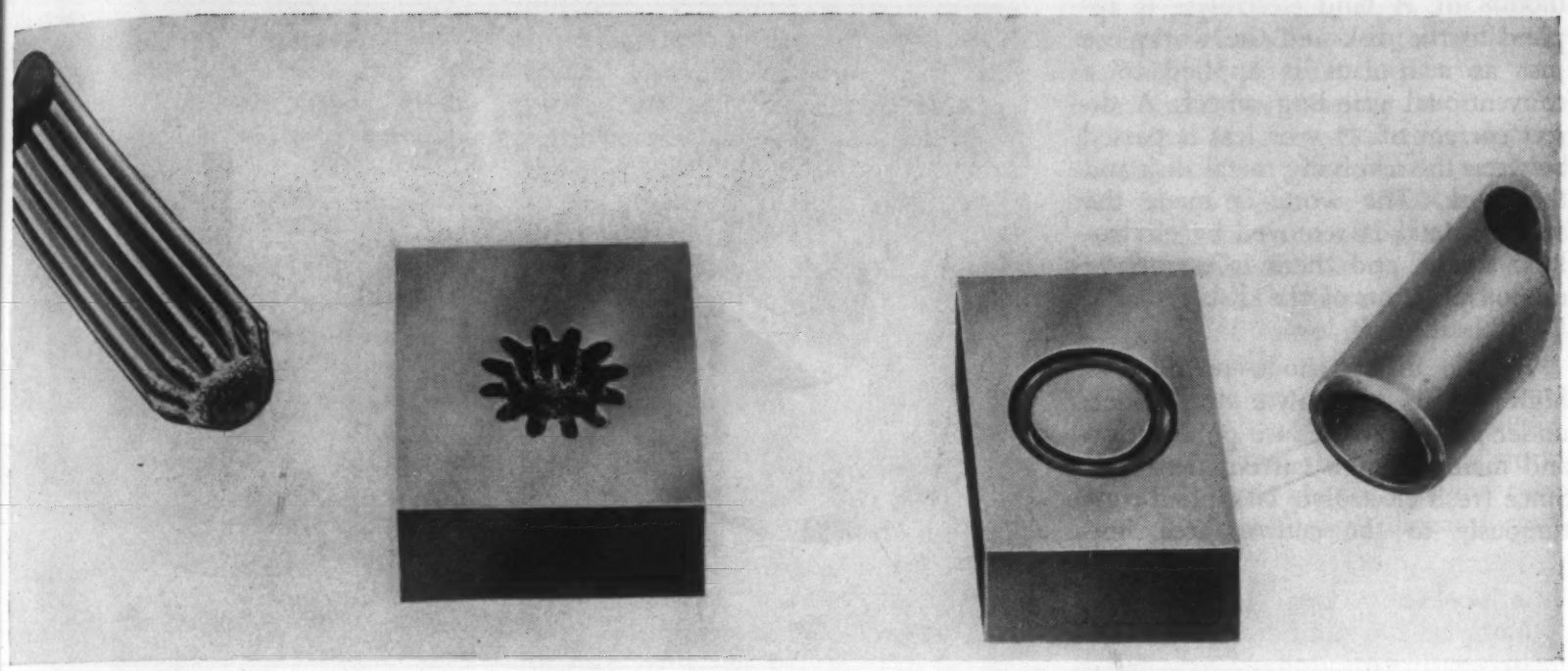
The new compounds will allow the silicones to expand into many fields where presently available compounds are inadequate. Indications are that their properties will be used extensively in unsupported films, O-rings, coated fabrics, gaskets, and for wire coatings and insulation. Automobile tire innertubes and V-belts are also distinct possibilities.

The new compounds are not being produced commercially and will not be turned out in volume for almost a year. However, small quantities for experimental uses will be available during that period. Cost of the new compound will be approximately the same as for the presently available silicone rubbers.

New rubber's properties being tested on Scott Tester.



Electron microscope at Yale was used in study of pigments for new silicone.

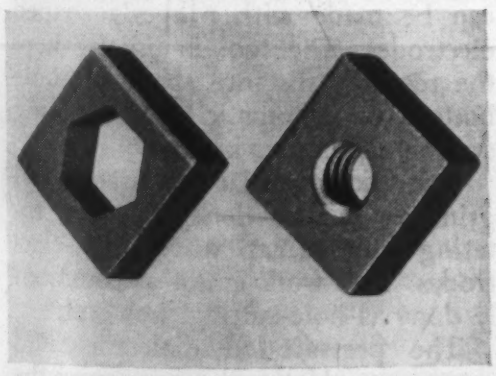


ELECTRO-SPARKING produces gear and ring compacting die sections directly in solid sintered carbide by electro-sparking. The hole is the same shape as the electrode. (Firth Sterling Steel & Carbide Corp.)

New Methods for Shaping Difficult-to-Machine Materials

..... Hard metals, carbides and ceramics are machined rapidly and accurately. .... These techniques now competing with conventional machining and grinding.

by **PHILIP O'KEEFE**, Associate Editor, Materials & Methods



WITH ELECTRO-ARCING process, tolerances of 0.001 in. are held on a hole in hex shape carbide blank. A class 3 thread is cut by the same method. (Arc Machining, Inc. and Elox Corp. of Michigan.)

● IN RECENT YEARS several promising methods of machining hard materials have been developed to supplement conventional grinding. These techniques include: (1) electrolytic; (2) electro-sparking; (3) electro-arcing; (4) ultrasonic; and (5) combinations of the first four. Three of these processes are now used industrially. Each process has limitations as to materials that can be machined, speed, surface finish, tolerances and shapes that can be made. Each has inherent advantages, too, and is promising for some type of work.

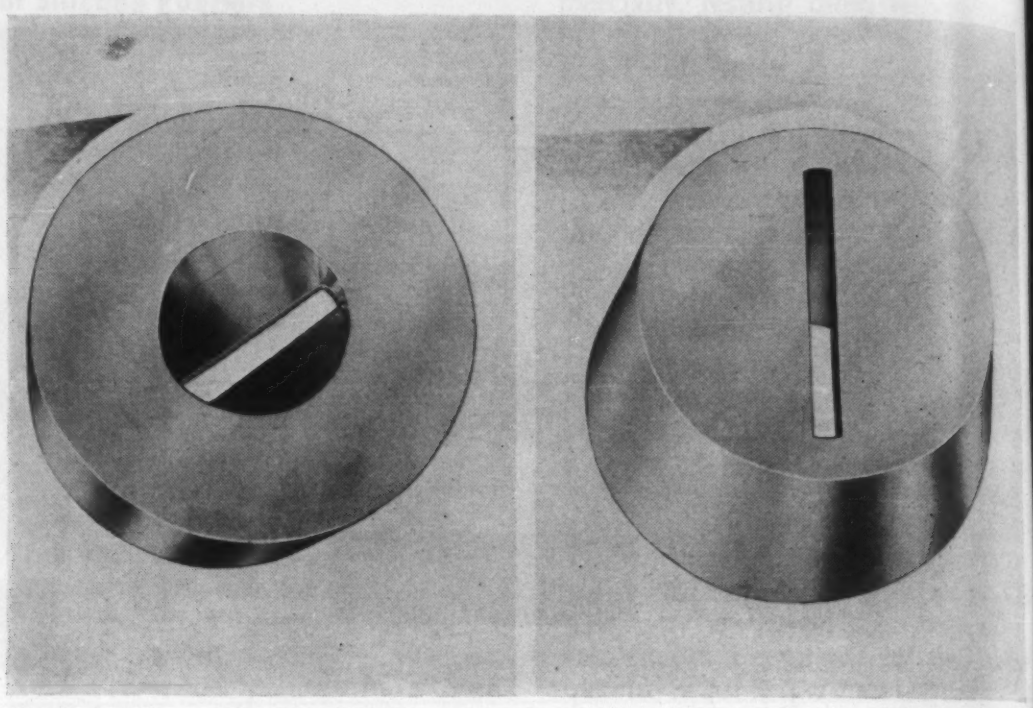
Because of the newness of the processes, nomenclature has not been standardized, and there are disagreements on theoretical explanations and on the capabilities of some of the processes. Also, since no work comparing the processes has been published, preformance claims and theoretical explanations are difficult to check. Therefore, this resumé of the new techniques must depend almost soley on information from the manufacturers of the machines.

Electrolytic Process

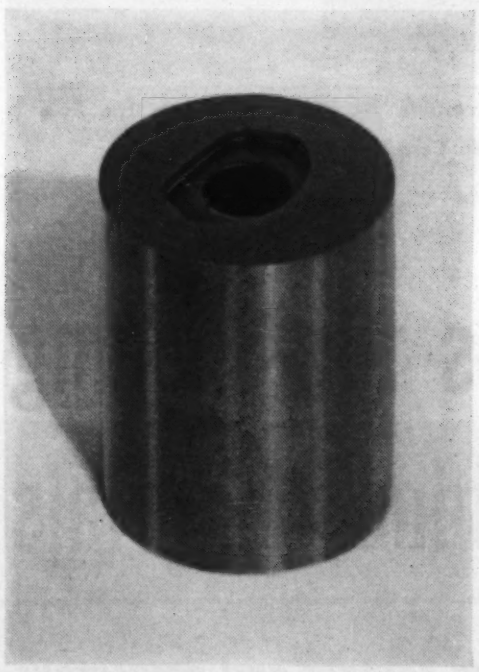
In electrolytic grinding, a metal disk revolves in close proximity to the work piece. The distance between the disk and the work is about

0.0008 in. A fluid electrolyte is applied to the disk and the workpiece just as a coolant is applied to a conventional grinding wheel. A direct current of 25 v or less is passed between the revolving metal disk and the work. The work is made the anode. Metal is removed by electrolytic action, and there is essentially no consumption of the disk cathode. Local heating is low.

As the disk cathode revolves at high speed, electrolyte is applied under pressure to reduce polarization and maintain high current densities. Since fresh electrolyte is applied continuously to the cutting area, the dissolution products are removed rapidly.



Water descaler nozzle shaped from a solid section of sintered carbide by electro-sparking. (Firth Sterling Steel & Carbide Corp.)



Cold header die is machined from carbide in a single pass by electro-arcing machine. No lapping required. (Elox Corp. of Michigan.)

The correct gap distance between the wheel and the work is important. As the gap increases, the current decreases, lowering the rate of metal removal. If, on the other hand, the gap is too small, arcs or sparks occur between the work and the wheel, wearing the wheel and damaging the finish of the work.

Several methods are used to maintain the right gap. A spring and solenoid arrangement keeps the current conducted constant, thereby stabilizing the gap. Another technique is to embed insulating spacers in the metal surface of the cathode wheel. These spacers protrude evenly above the wheel surface and bear on the work with just enough pressure to maintain contact.

Insulating spacers are required for tungsten carbide grinding. An insulating oxide film forms on tungsten carbide, and this film must be removed or further attack is prevented. The oxide is soft, however, and is easily wiped off by the spacers.

Electrolytic grinding has several advantages. There is no wear on the cathode wheel. Extremely good finishes (better than 5 micro in. rms) can be imparted to metal surfaces. These finishes are independent of the cutting rate. Since the wheel does not bear strongly on the work, grinding strains are eliminated.

The electrolytic process can only be used with electrically conductive materials like ordinary steels, high-speed steels, copper, aluminum, titanium and metal carbides. It is especially suitable for removing stock from large areas, but its applications are limited where very small surfaces must be ground or where deep, small diameter holes must be drilled. Any surface that a conventional grinding wheel can get at can be worked on with electrolytic grinding. The rate of metal removal which can be achieved with high-speed steel is about 0.15 in. per min. With sintered carbides, the removal rate is lower. The accuracy attainable with electrolytic grinding depends on details of the machine and its applications. No electrolytic machines are available commercially at present.

Electro-Arcing Process

In commercial electro-arcing machines now being made, the work is made the anode in an electric arc. The arc between the tool and the work is surrounded by a dielectric fluid. According to the machine manufacturers, the pulsating electrical discharges heat the work by electron bombardment. The area under the arc gets very hot, vaporizing the metal and cracking off solid particles by fast thermal expansion. These machines use 25 v or less, d.c.

Electro-arcing techniques can be used to drill or tap holes from 0.020-in. dia up. Holes 0.060 in. in dia or larger can be threaded. The tool is a tube or rod electrode, which is fed down through the work in the same way as a conventional drill. The arcs play between the end of the tool and the bottom of the hole. When a tube electrode is used, a core is cut out of the metal and the hole is trepanned out. In cutting round holes, the electrode is usually rotated. This rotation is not necessary, however, and irregular holes can be made with properly shaped electrodes. The tool is usually kept the required distance above the hole bottom by automatic servo feeding systems of various kinds.

Operations similar to conventional grinding can be done by using rotating ring or cap wheel tool electrodes. This work is not as commonly done as hole-cutting, however.

The pressure-fed dielectric fluid acts as a coolant and carries away the arc products. This fluid keeps the heating confined to the work area, so that adjacent metal is not damaged. The fluid also carries away the positively charged particles which break

off the work before they can reach the tool. This prevents rapid wear of the tool electrode. The coolant can be supplied from the outside, as in conventional machining, or through a hollow electrode.

The tolerances and finish obtained depend upon the material and the cutting speed. Finishes ranging from semi-polish to unusable roughness are possible. A fast, rough cut is often taken, followed by a slow, finishing pass. Finishes better than 60 micro in. rms can be obtained easily. Holes can be located within 0.001 in., and diameters can be held to $\pm$0.001 in.

Elox V-600 electron drill. Electro-sparking machines are used commercially to remove broken taps, drills, reamers and studs.

Electro-arcing can be used on any conductive material. It has been used principally on tool steels and cemented carbides. Commercial machines use this technique to extract broken taps. Electro-arcing is faster than any of the other methods discussed here, but usually leaves a comparatively poor finish, and burns the surface to some extent.

Electro-Sparking Process

The electro-sparking process seems to be similar to electro-arcing, except for the voltages and auxiliary equipment used. Voltages from 40 to 400 v, d.c., are used in electro-sparking. The tool electrode shapes and work that can be done are the same as in electro-arcing.

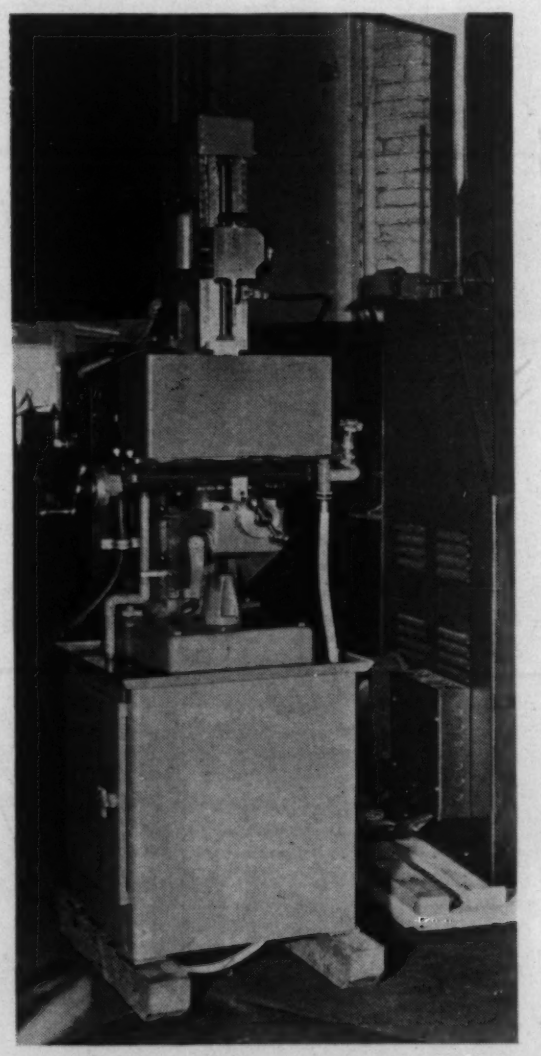
The process, according to the manufacturer's explanation, is entirely different, however. With electro-sparking there is no burning of the metal. Particles of the work are broken off by concentrated electrostatic forces as sparks jump through the surrounding fluid from the tool to the positively charged work. The fluid used is a dielectric. There is said to be no melting, burning or visible oxidation on the surface.

The difference between electro-arcing and electro-sparking may be a matter of degree. The individual electrical discharges are shorter in electro-sparking, due principally to the higher voltage. This makes the process slower, but cuts local heating and improves surface finish. The tolerances and finishes are better with electro-sparking. Finishes as low as 26 micro in. rms can be attained. Holes are located within $\pm$0.0001 in., and diameter tolerances can be held to $\pm$0.0005 in. The same shapes can be cut by both processes.

Ultrasonic Process

Unlike the other processes, the ultrasonic method does not use electric current or discharges for stock removal. A tool is made with an end shaped in the outline of the hole, cavity or contour to be cut. This tool is connected to a device which vibrates the end, at frequencies from 16,000 to 29,000 cycles per sec through an amplitude of a few thousandths of an inch. The tool is pressed against the work and a mixture of finely divided abrasive (boron carbide) and water is flowed on the work around and under the tool end. Under light, continuous pressure the tool sinks into the work to form a hole shaped like the tool itself. The tool is consumed during the process.

Non-metals and non-electrically conducting materials can be ground in this way. Complicated shapes, such as internal threads, can be cut. Roughing operations are carried out to accuracies of 0.002 in. with surface finishes in the order of 25 micro in. Higher accuracy and finer finishes can be obtained by using finer grit sizes. The stresses involved are very low and there is no local heating. As a result, there is no thermal cracking, pitting or burnt color on the work.



The Method-X machine developed by Firth Sterling Steel & Carbide Corp. uses the electro-arcing method of machining.

Combination Processes

In addition to these four methods, combination processes have developed. These involve two or more of the electric techniques. Electro-sparking and electro-arcing blend into each other. It is also possible to combine one of them with electrolytic methods. Another possibility is the combination of regular grinding with an electric method.

One recently announced machine combines electrolyte and electro-sparking methods. A metal wheel is run in contact with the work. The wheel is made the cathode in the circuit. The cutting effect is independent of the hardness of the work. Cutting time decreases with wheel speed. It is thought that the machine vibration causes tiny arcs between the work and the revolving anode. The theory is that both electrolysis and arcs erode the work.

Acknowledgment

We gratefully acknowledge assistance from the personnel and publications of the following companies:

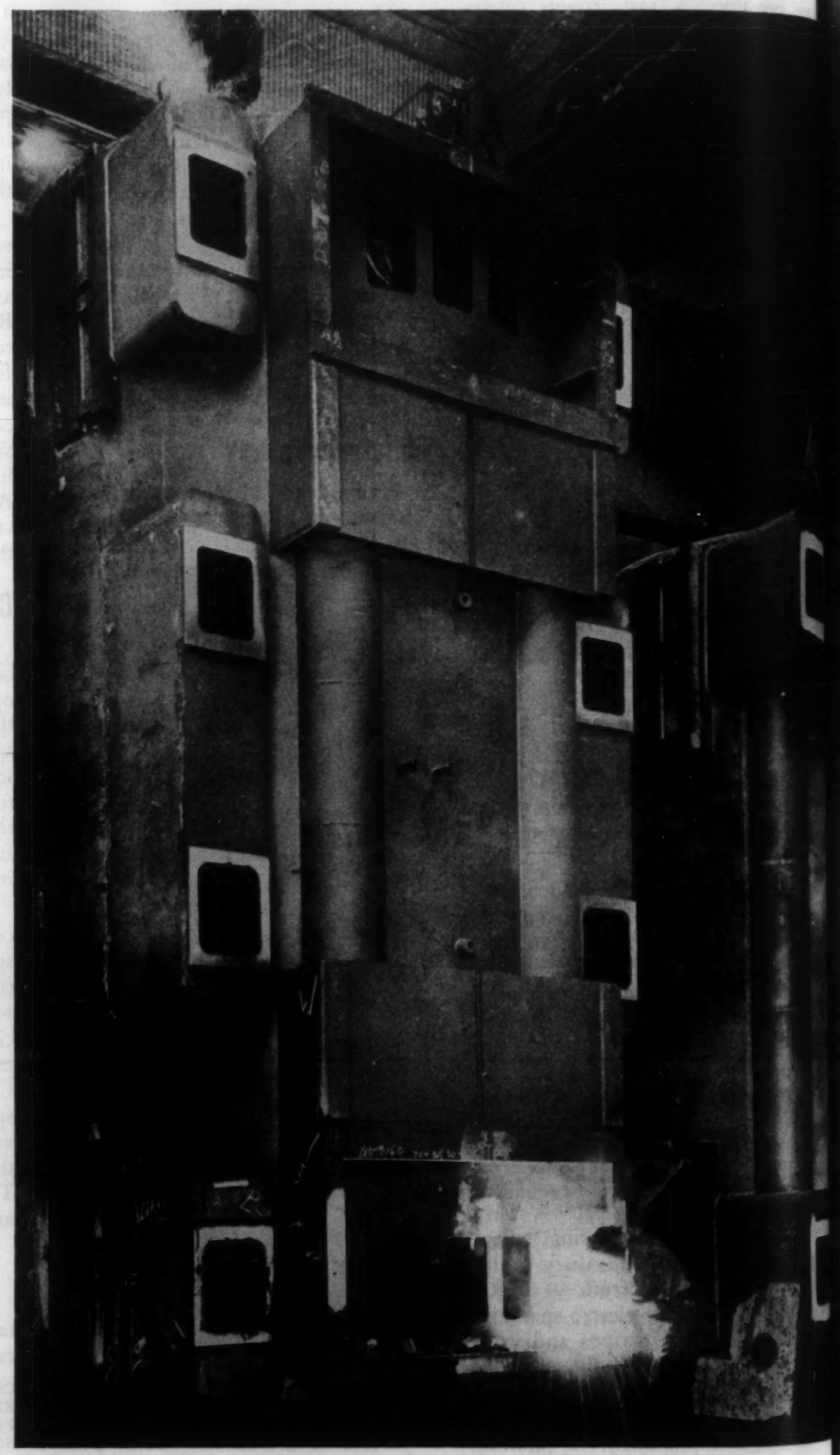
Cincinnati Milling Machine Co.
Elox Corp. of Michigan
Firth-Sterling Steel & Carbide Corp.
Super-Cut Inc.

Materials at Work

Here is materials engineering in action . . .

New materials in their intended uses . . .

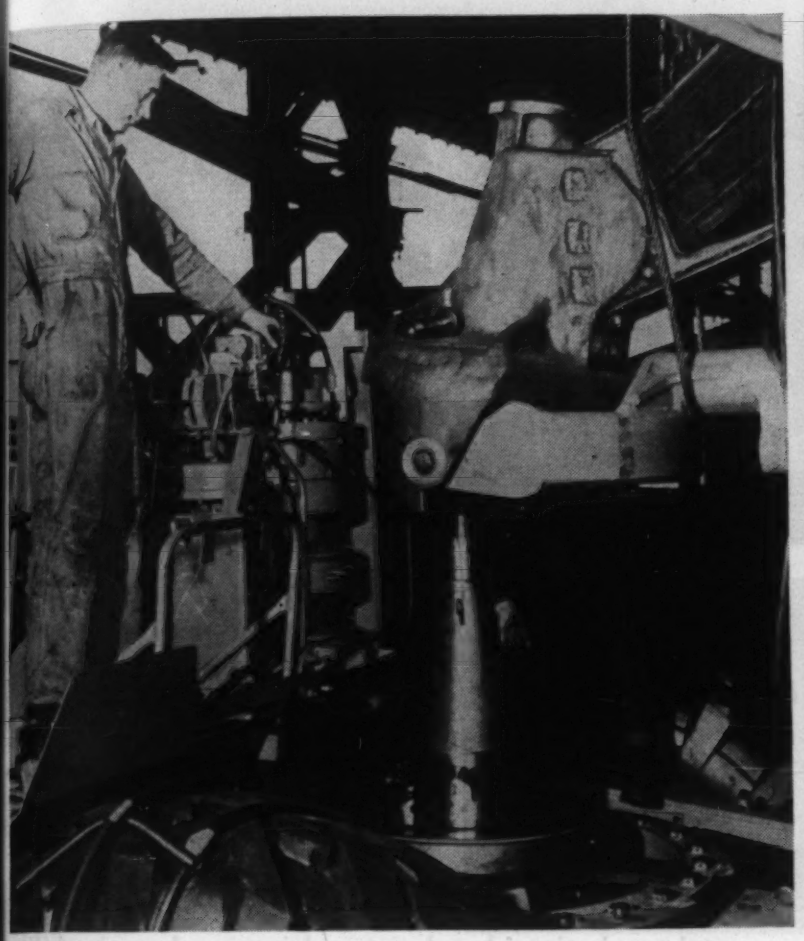
Older, basic materials in new applications . . .



STATOR FRAME WELDMENT
Requiring more than 3000 ft of welds, this giant generator stator receives its finishing arc welding touches at the General Electric Co.'s Schenectady, N. Y., Works. Huge stator frames like this are welded in three positions. In the horizontal and vertical positions, AWS-E6010 electrodes are used. In the third position, the frame is placed horizontally on a set of Ransome turning rolls and rotated so that most of the welding can be done flat to take advantage of the greater deposition rates of large size electrodes. For this flat welding, AWS-E6020 welding electrodes are used.

PHENOLIC LAMINATE WASHER The Wooldridge Manufacturing Co. manufactures earth-moving and road-building equipment. Prominent in their line of heavy-duty scrapers is the Terra Cobra, a semi-trailer unit with an exceptional carrying capacity. With a full load, the combined weight bearing on the king pin mechanism is often in excess of 50 tons.

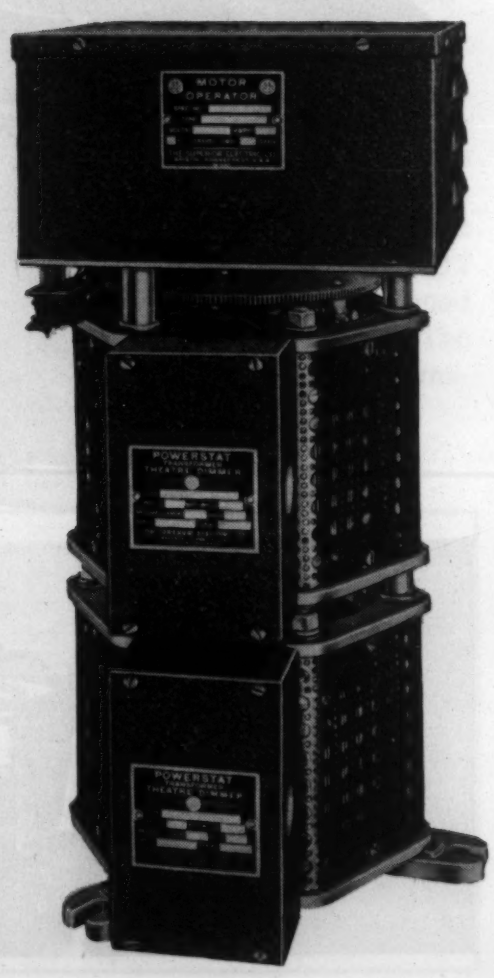
Since the unit is designed to operate under all types of terrain conditions, the ability of a thrust washer to take severe punishment is essential. Phenolic laminate, supplied by the Formica Co., was elected to carry the direct burden of the entire trailer unit. The thrust washer not only sustains the weighty load, but also acts as the plate upon which the trailer unit swivels when a turn is made. Made of Grade C material, it is about 1 in. thick and 17 in. in dia.



PLASTIC COIL CLAMPS Light effects are controlled by the Powerstat Dimmer, made by Superior Electric Co. Since the unit is a transformer, it is connected across the power line. It transforms power, in the correct amount, to achieve the desired lamp brilliancy.

Of particular interest are the Formica (phenolic and urea) coil clamps used on this unit. They are a combination molded and macerated part. The macerated material forms the body of the part, and the laminations form the lip, which must be strong enough to support the coil, particularly on units that are used by the armed services or in mobile equipment.

The clamp is a mechanical support of high strength; it offers a resilient clamping surface against the coil which conforms to the coil wires without damaging the coil. The part also acts as an electrical insulator between the coil and the supporting frame. Originally, Superior used heavier metal supports which had to be insulated individually. They did not offer the semi-rigid surface against the coil that is necessary for firm support without damage.

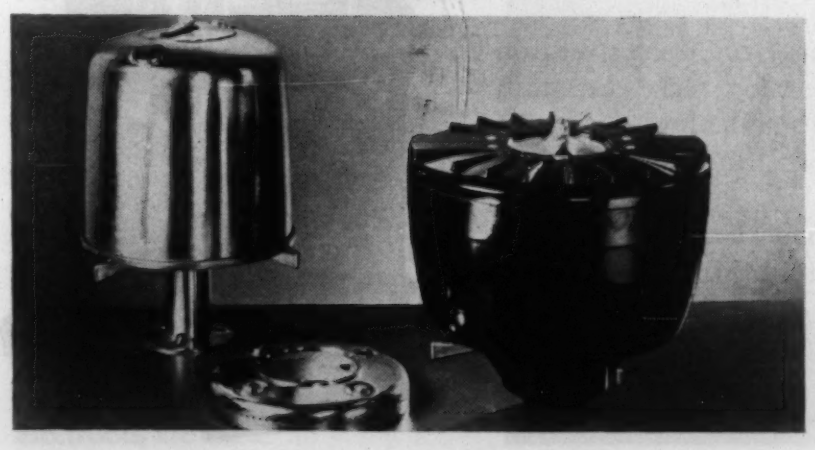


Materials at Work

REINFORCED PLASTIC TANKS Fuel and water tanks for service in the Saudi Arabian deserts are being made of Fiberglas mat reinforced Laminac, produced by American Cyanamid Co. The tanks are molded by Carl H. Beetle Plastics Corp.

The steel tanks formerly used rusted in the night dampness and were worn away in sandstorms. The plastic units are expected to be in service 10 to 50 times as long. The plastic tanks are also lighter and do not corrode with the salt in crude petroleums. Repairing the plastic tank requires only a patching kit. Steel tanks had to be welded.

The walkways along the side of the truck are also reinforced plastic, as is the housing for the pumping mechanism.



PHENOLIC SOAP DISPENSER A recent switch from metal to plastic reduced cost and increased serviceability of the soap dispenser made by the Bradley-Washfountain Co. Molded of Durez phenolic, the 12- by 9-in. unit is part of a washfountain assembly.

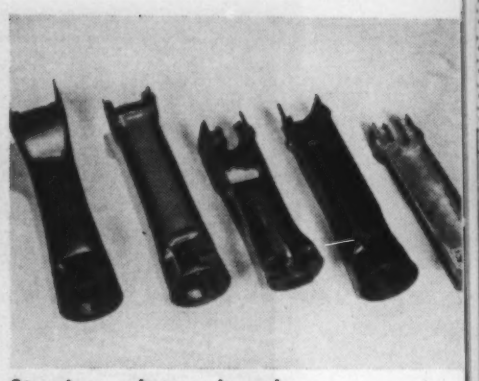
The metal housing on the original model was made in one piece with a separate part for the cover. A supporting tube connected the dispenser to the water sprayhead on the wash basin. The new, all-plastic dispenser is molded in two pieces with the two molded parts serving as covers. Assembly is easy, and the unit is attached directly to the sprayhead of the basin. The supporting tube is eliminated.

Because the metal dispenser was made in one piece, it was often necessary to sacrifice service. On semicircular washfountains, half the dispenser was out of reach and useless. Now, with the two-piece construction of the new plastic dispenser, it's possible to disassemble the complete unit and use only half of it when desired.

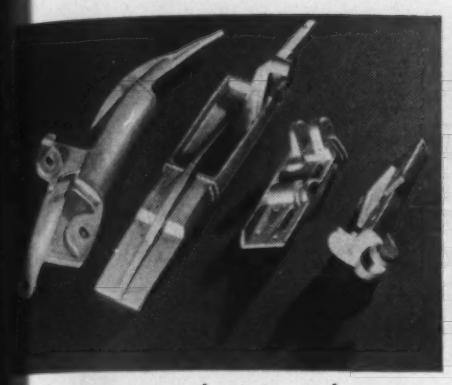
By designing the new dispenser with these two separate halves, both liquid and powdered soap can be supplied from the complete fixture. Only one type of soap could be stored in the old model. The large cover design on the plastic dispenser makes filling easy.

Dickten & Masch Mfg. Co. do the molding for Bradley Washfountain Co. While the primary aim of the new design was greater capacity, this goal was reached without additional cost.

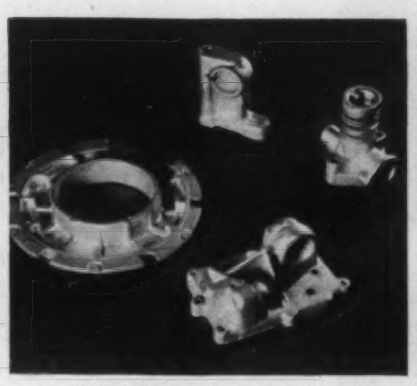
Convertible folding top pillar



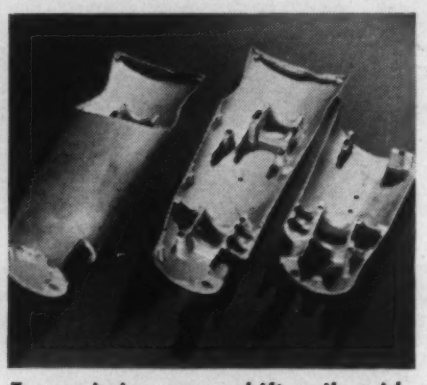
Steering column shrouds



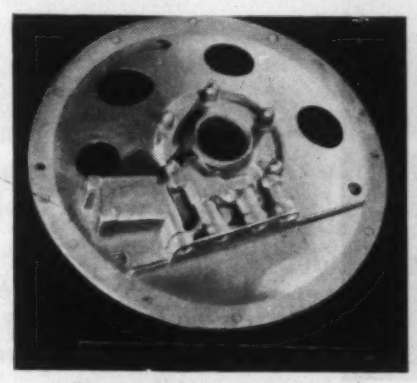
Instrument panel parts and gear shift assembly flange



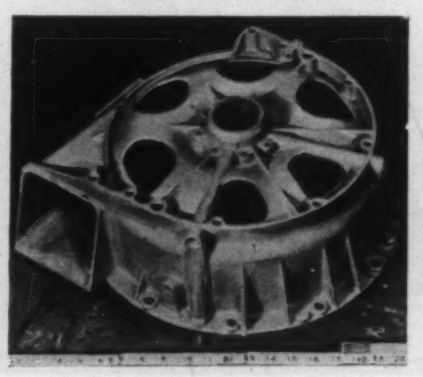
Clutch housing



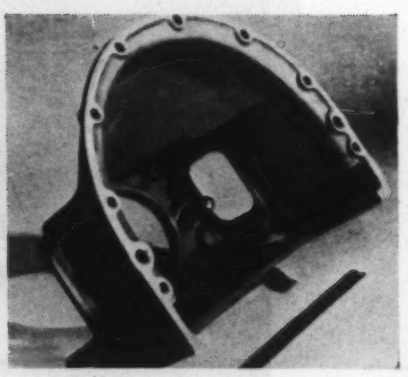
Transmission gear shift rail guide and oil seal plate



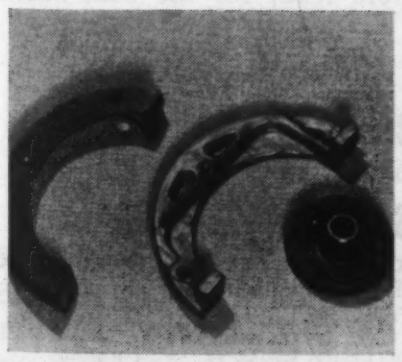
Torque converter housing



Parts for automatic transmission



Steering column jacket



Ignition distributor housing

Generator and plates

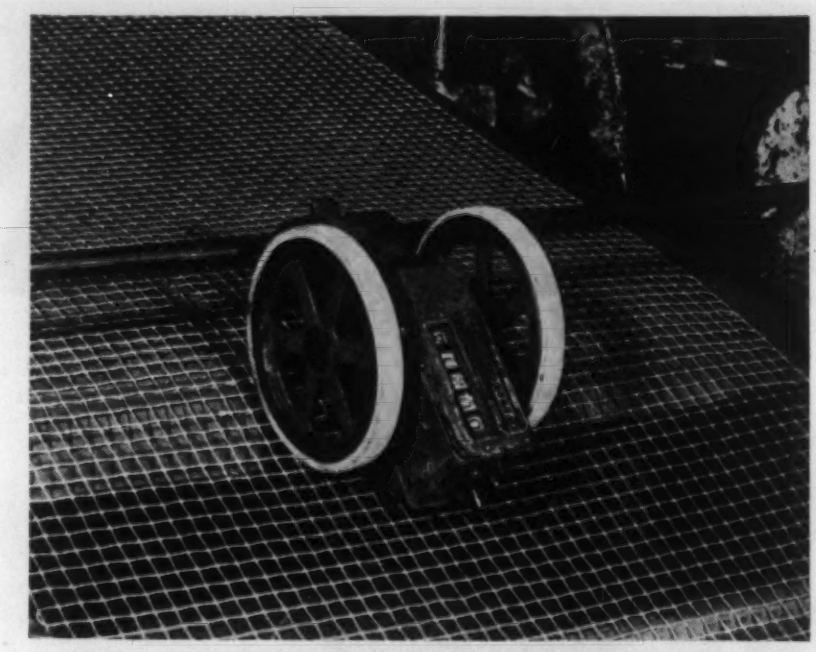
MAGNESIUM AUTOMOBILE PARTS

Some magnesium is being used in almost every make car this year. Chrysler, however, is using more in production models than any other company. Sixteen die cast and permanent mold cast parts are used in 1952 Chrysler cars. These parts are lighter and as good or better than they would be in other materials. The light metal is cheap to machine, gives a good machined finish, and casts well.

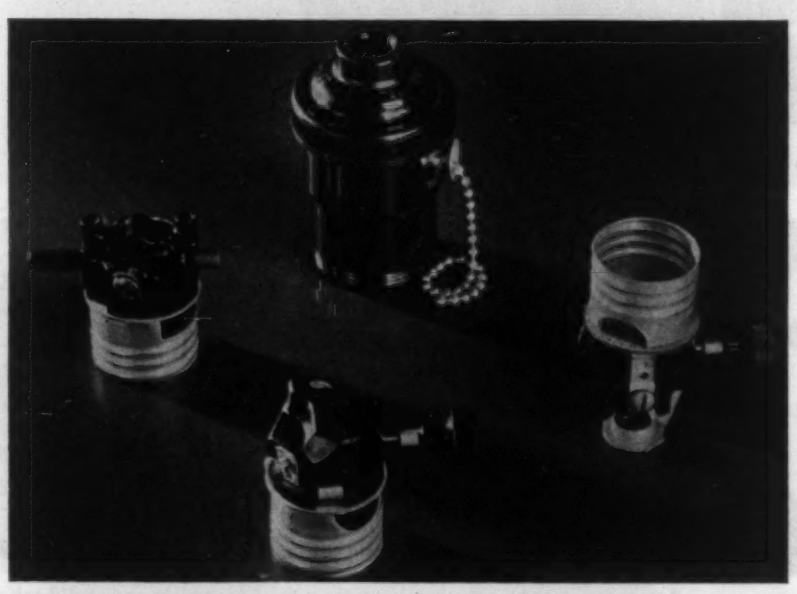
Magnesium Castings in 1952 Chrysler Cars

PART	Weight (lbs) of Magnesium	Material Replaced	Weight (lbs) of Replaced Part
FOLDING TOP PILLAR (CONVERTIBLE MODELS)	2.85	Zinc	11.40
STEERING COLUMN SHROUD	1.85	Zinc	7.03
STEERING COLUMN BRACKETS	0.26	Zinc	0.99
INSTRUMENT PANEL COVER	0.18	Zinc	0.68
INSTRUMENT PANEL CLUSTER RING	0.15	Zinc	0.57
GEAR SHIFT LEVER BRACKET	0.11	Zinc	0.42
ENGINE FRONT OIL SEAL PLATE	0.24	Zinc	0.91
ENGINE OIL PUMP AND COVER	0.86	Zinc	3.44
ENGINE OIL FILTER BODY	0.54	Steel	2.16
TRANSMISSION GEARSHIFT RAIL GUIDE	0.11	Zinc	0.42
GEAR SKIFT HOUSING	0.68	Cast iron	2.72
CLUTCH HOUSING	7.00	Cast iron	28.00
TORQUE CONVERTER HOUSING	12.00	Cast iron	48.00
RADIATOR FAN SPACER	0.24	Zinc	0.96
IGNITION DISTRIBTOR HOUSING	0.62	Zinc	2.48
CARBURETOR BODY	1.30	Zinc	4.94

Materials at Work



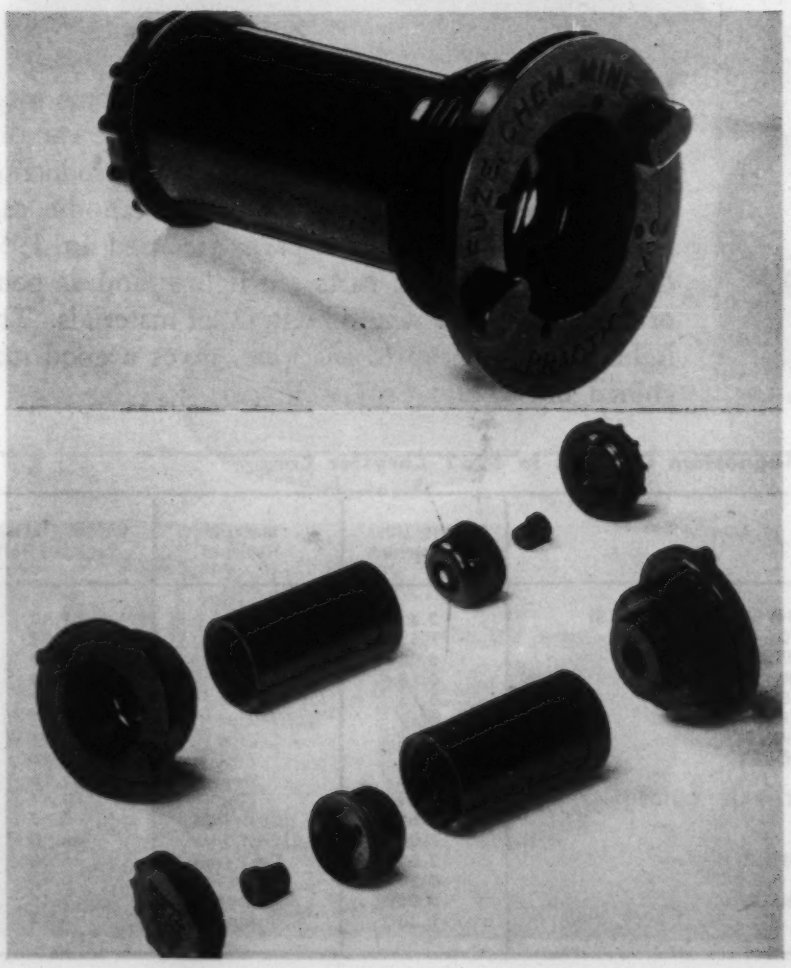
NYLON COUNTER RIMS Unusual use for nylon is the rim on a counter which measures the length of wire screen. Various kinds of rubber rims had been previously used. None lasted longer than three weeks. It was constantly necessary to check the wheel diameter, since even slight wear meant that the customer would get a short length. Nylon rims in service for more than seven months show no measurable amount of wear. The rims are made from FM-10001 nylon tubing supplied by The Polymer Corp. of Pennsylvania.



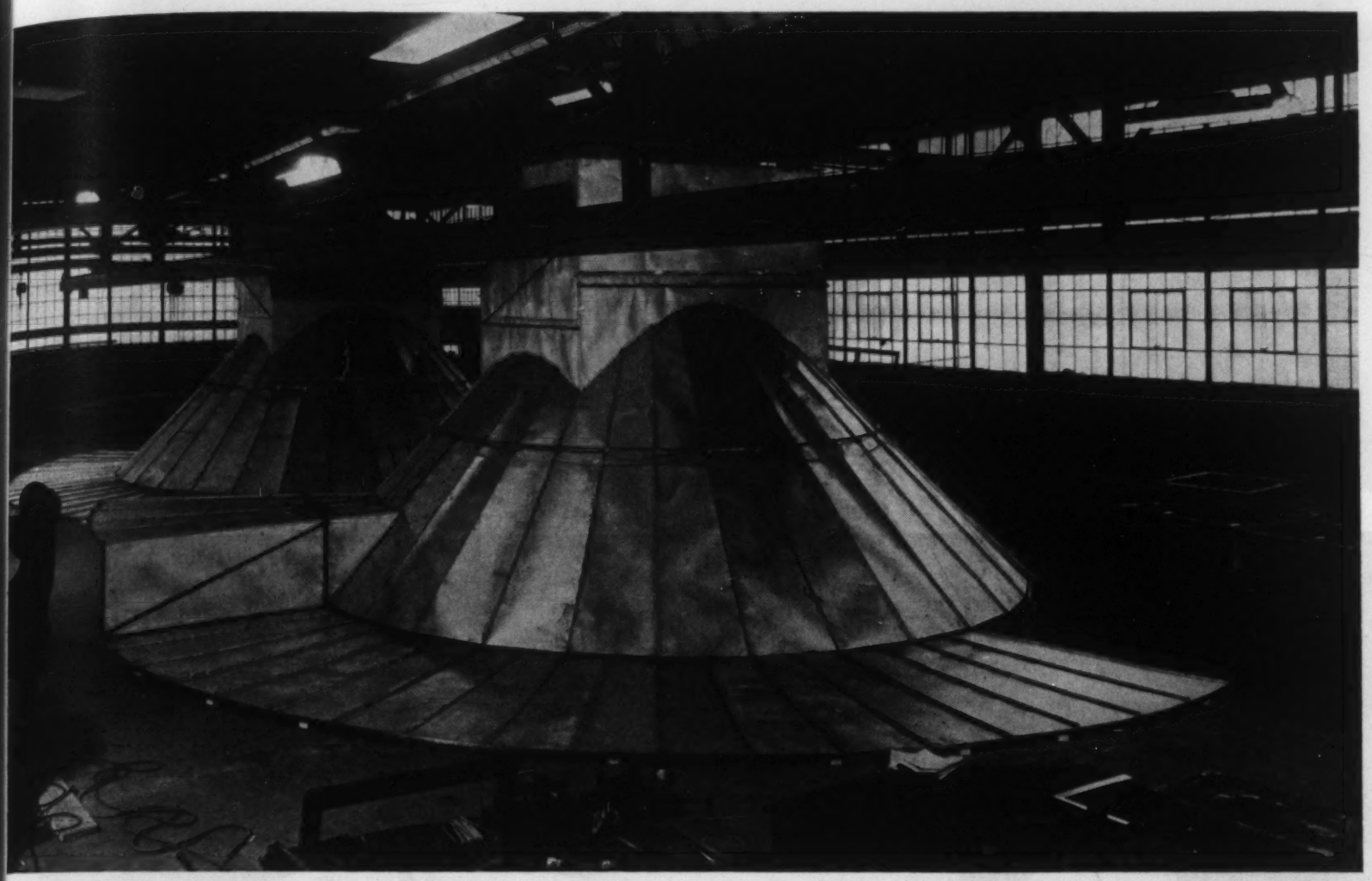
LIGHT SOCKET MATERIALS How to combine the advantages of metal and plastic is demonstrated by an electric light socket assembly made by the Circle F Mfg. Co. The materials selected possess different, distinct and important properties.

The ability of metal to conduct an electrical current is the main reason for its use in the shell which accommodates the bulb, and in the contacts. On the other hand, the socket housing is molded of Durez. The housing has two jobs to perform—it protects and insulates. Self-insulation is a strong argument in favor of the phenolic supplied by Durez Plastics and Chemicals, Inc. The phenolic has high heat resistance and is extremely durable with a molded-in smooth finish. Of equal importance is the light weight, which helps to lower shipping and handling costs.

The socket housing is molded in three sections with a screw-on top for easy assembly. The phenolic used in the internal units is permanently molded around the metal parts. All parts, even of the most intricate design, are delivered from the mold ready for use with inserts and holes molded in.



PHENOLIC MINE FUSE Auburn Button Works, Inc., Auburn, N. Y., is molding Bakelite phenolic precision fuses for nonmetallic practice land mines manufactured by Onondaga Pottery Co., Syracuse, N. Y. Five parts for the unit are molded: the safety cap, which is removed to fuse the mine; the plunger, to detonate the fuse; the plunger cylinder; the fuse housing; and the top cap, to secure the fuse into the mine. Both left- and right-hand threads are molded on the inside of the fuse housing and on the top cap. The thread on the plunger cylinder is precision molded to come to the very edge of the piece. Ordinarily this would cause feather edging on the mold. But specially designated molds eliminated this, and thousands of these parts have been produced without damage to the cavity. A special drilling fixture was designed in order to bore a 0.124-in. dia. hole in the body of the fuse. In the top cap, there are also four 0.028-in. dia. holes drilled, two at a time. The length of the bore is 7/8-in., and there is only about 0.030-in. wall between the edge of the holes and the inside diameter of the thread.



MONEL HOOD AND STACK ASSEMBLY Salt that goes into processed foods can tolerate no more than the minutest trace of heavy metals. This creates problems in salt making. The brine may pick up metallic contamination from the refining equipment.

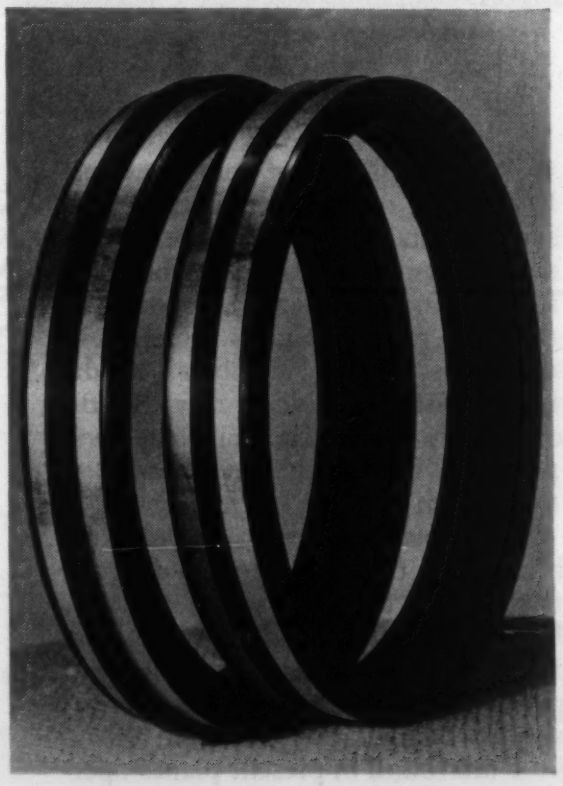
One manufacturer of high grade salt had trouble with salt vapors scaling metal hoods over evaporating pans. The vapors condense on the hoods and drip back into the pans. This made contamination possible.

Hood and stack assemblies constructed of 26-gage Monel was the answer. It retains corrosion resistance in the rolled sheet and in the weld areas. There was no surface treatment to mar or wear off.

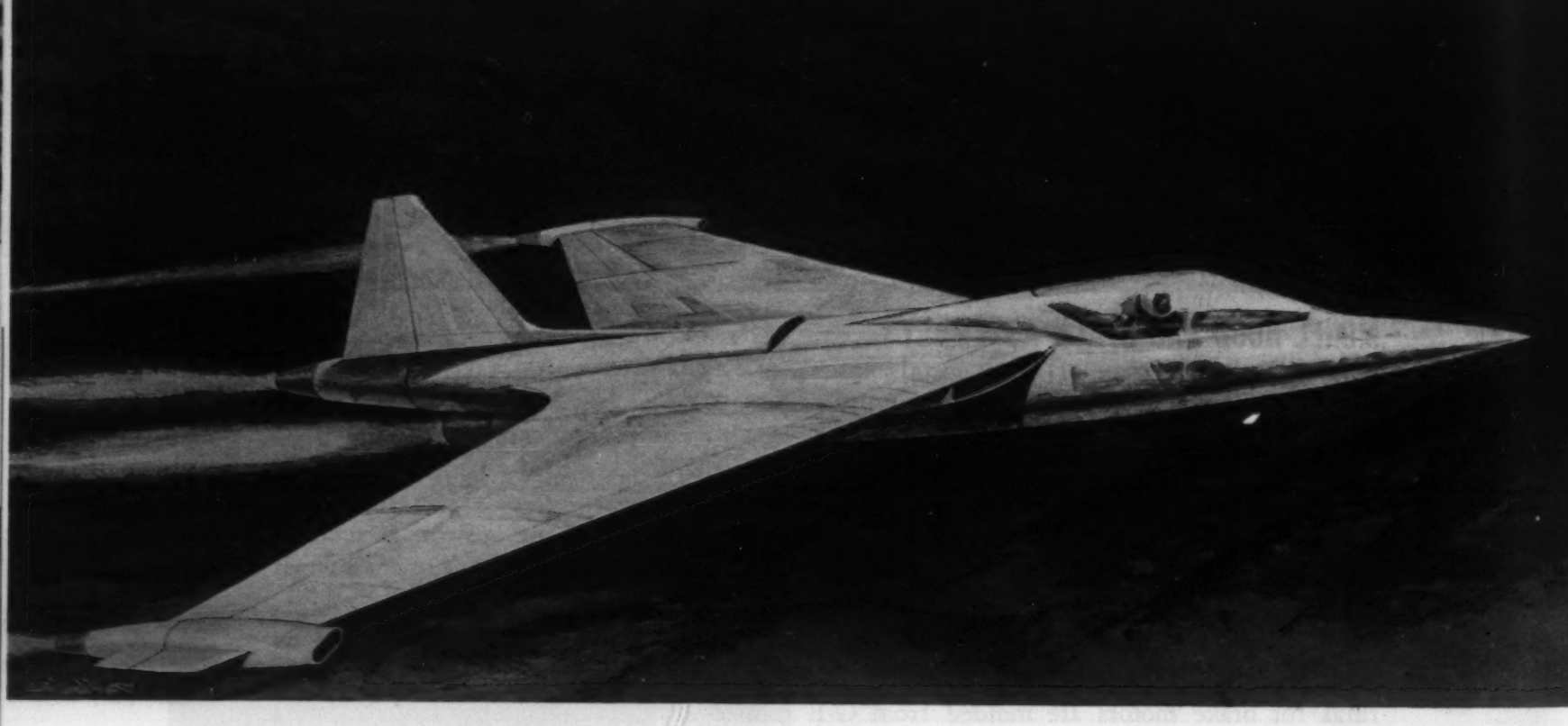
RUBBER-PHENOLIC COLLECTOR RINGS Collector rings for brake motors are molded from G-E rubber-phenolic compounds manufactured by General Electric's Chemical Div., resulting in cost reductions and improvement in electrical characteristics. The rings are being molded by the Rockford Molded Products Co. for the Warner Electric Brake & Clutch Co.

Before rubber-phenolic was adopted for this application, brass slip rings were shrunk on a laminated tube. This method proved costly and did not make an adequate barrier to current creepage. When molded rings were tried using conventional phenolics and brass rings as inserts, cracking resulted due to the varying shrinkage coefficient between the two materials.

Because of the high internal resiliency of rubber-phenolic, the assembly is now being produced by further compressing the brass rings into the molded part after molding. Ordinary phenolics fractured when this method was tried. By using rubber-phenolic, it is possible to produce collector rings with a minimum of breakage. Lower costs and improved insulating characteristics have also been obtained.



High-Speed Airplanes of Future Need New Materials



● THE AIRPLANE of tomorrow may have glass reinforced plastic wings, ailerons, stabilizers and fuselage. It may be fastened with glass fiber reinforced plastic rivets and supported by titanium and stainless steel low-density structural members. A dry heat resistant powder may be the chief lubricant. The airplane will probably be easier and cheaper to make than present airframes.

New materials will be required because of the heat generated by air friction on airplane surfaces at the high speeds planned for the near future. The skin temperature rise is proportional to the square of the speed. Temperature rises of 70 to 90 F are found in present planes operating near the speed of sound. Refrigerating equipment is needed to keep occupants comfortable. As flying speeds increase, temperatures will soon become too high for presently used aluminum and magnesium alloys. At 1300 mph, the temperature rise is about 260 F; at 2600 mph, the rise is more than 1000 F. Something other than the conventional light metal alloys will be required to stand heat like this.

Thomas E. Piper, Chief Process and Materials Engineer, Northrop Aircraft, Inc., thinks that glass reinforced phenolic or silicone materials will be the best answer. The following is a resumé of the Northrop engineer's ideas on what lies ahead in airplane materials.

Magnesium and aluminum appear limited as future high-speed skin materials. Above 300 F, the common alloys of both metals lose strength. The tensile strength of the most heat resistant aluminum alloy, 24S-T, is 62,000 psi. After 100 hr at 500 F, 24S-T drops to 18,000 psi. The tensile strength at 500 F is 30% what it is at room temperature. At 500 F, 75S-T loses 80% of its strength. The Aluminum Co. of America and Dow Chemical Co. are trying to increase the heat resistance of aluminum and magnesium. Alloys of magnesium and rare-earth elements retain good strength properties above 300 F. Alcoa's search for

a higher temperature substitute for 24S-T is reported to have met "limited" success.

Glass-Plastic Laminates

Glass-plastic laminates, on the other hand, offer considerable promise for high-speed service. Phenolic and silicone laminates have good strength-weight ratios and retain a high percentage of their strength at 500 F. A phenolic-glass material, for example, has 80,000 psi tensile strength at room temperature, about the same at 300 F, and retains 35,000 psi after 100 hr at 500 F. These laminates also have a lower coefficient of expansion than metals, and would be less likely to warp with temperature changes. Surfaces would be smoother, without rivets, screws and skin joints. Tooling would be simplified with these materials and the labor costs on an airplane would be lower. If resins can be developed with the desired high temperature properties, plastic-glass airplanes may go into production in the not-too-distant future.

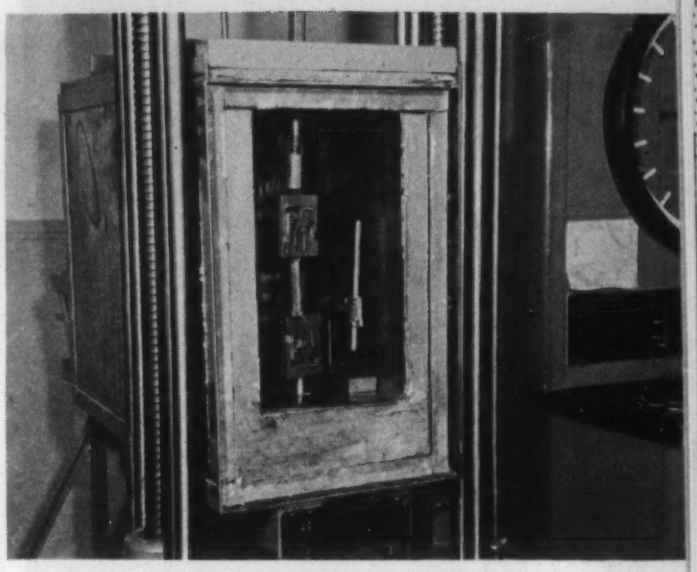
Research is also being done on glass-plastic rivets. These will, if developed successfully, probably consist of glass roving impregnated with silicone or phenolic resin. They would have good fatigue strength. Experimental rivets of this type have so far proved unsatisfactory, however.

Titanium and Stainless

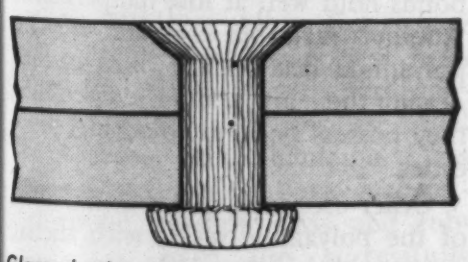
Titanium and stainless steel stand next to glass-plastic as possible materials for future airplanes. The good strength - weight ratio, corrosion resistance and heat resistance of the metals are well known. Titanium also has high fatigue strength under dynamic fatigue loading.

Before stainless steel and titanium can be used successfully in future high-speed aircraft, however, low density structural forms of these metals must be developed. Light weight extrusions are possibilities. A limitation to metallic honeycomb is the present lack of bonding methods to withstand the high operating temperatures in high - speed airplanes. Substitutes must be found for organic adhesives. Improved welding, soldering and brazing techniques should receive attention. Corrugating and diamond punching techniques may also be developed for lightweight stainless steel and titanium structural forms. Large, thin castings also have an important role in future aircraft. Cast sections 0.01-in. thick, with less than 1 deg draft, must be made possible so that light castings can replace assemblies now fabricated from a number of parts.

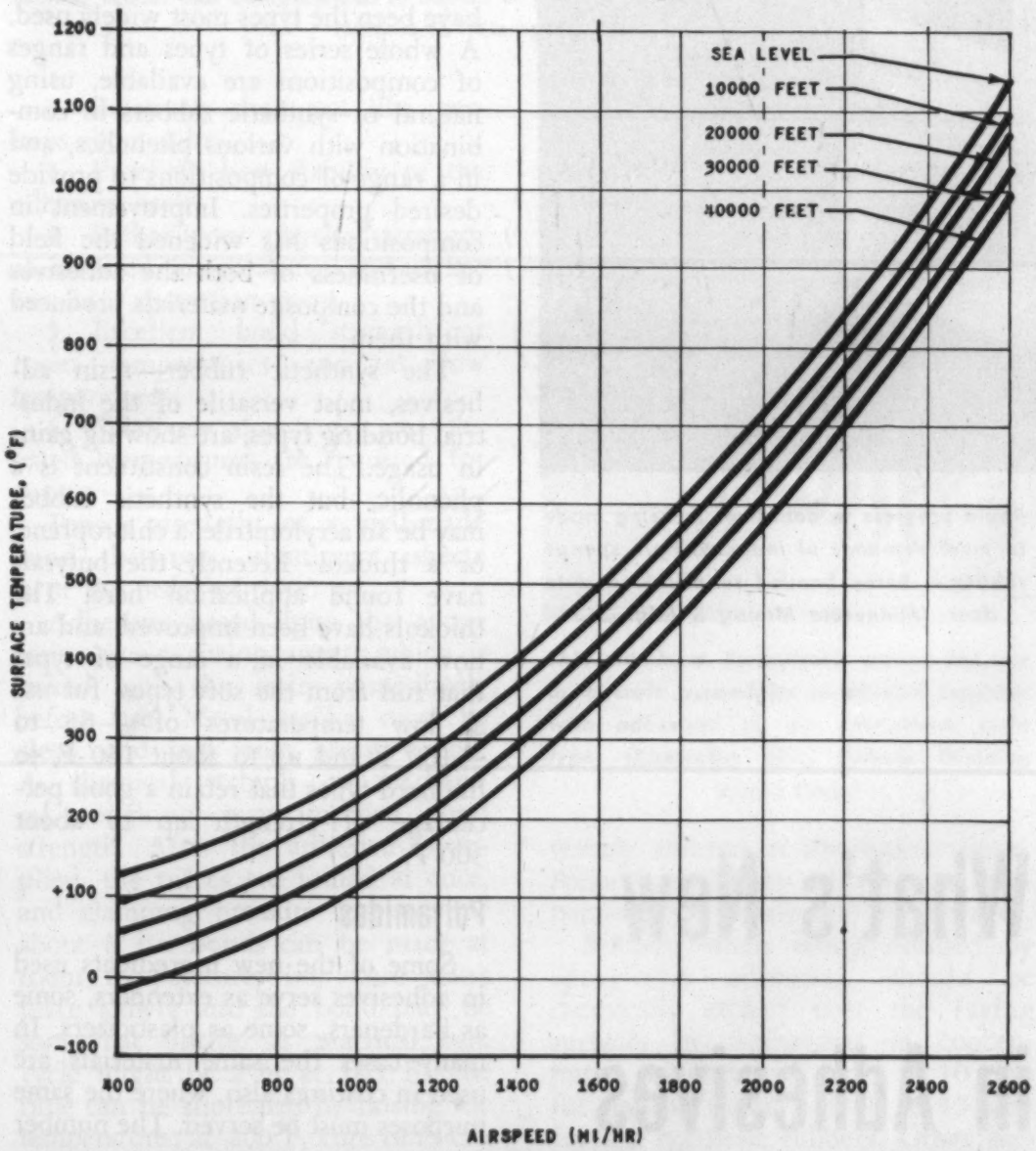
Many new nonstructural materials will also be required by future aircraft. High temperature lubricants will probably be dry powder or dry film types like molybdenum disulfide, with or without a carrier. Wet lubricants developed for 350 to 700 F will probably be unsatisfactory for extremely low temperatures. They may also have poor lubricity or undesirable toxic or corrosive properties. The methacrylate plastic now used in cockpit canopies must be changed to silicate glass. Heat resistant rubber will have to be developed for all seals. Better surface finishes are another requirement for very high-speed airplanes.



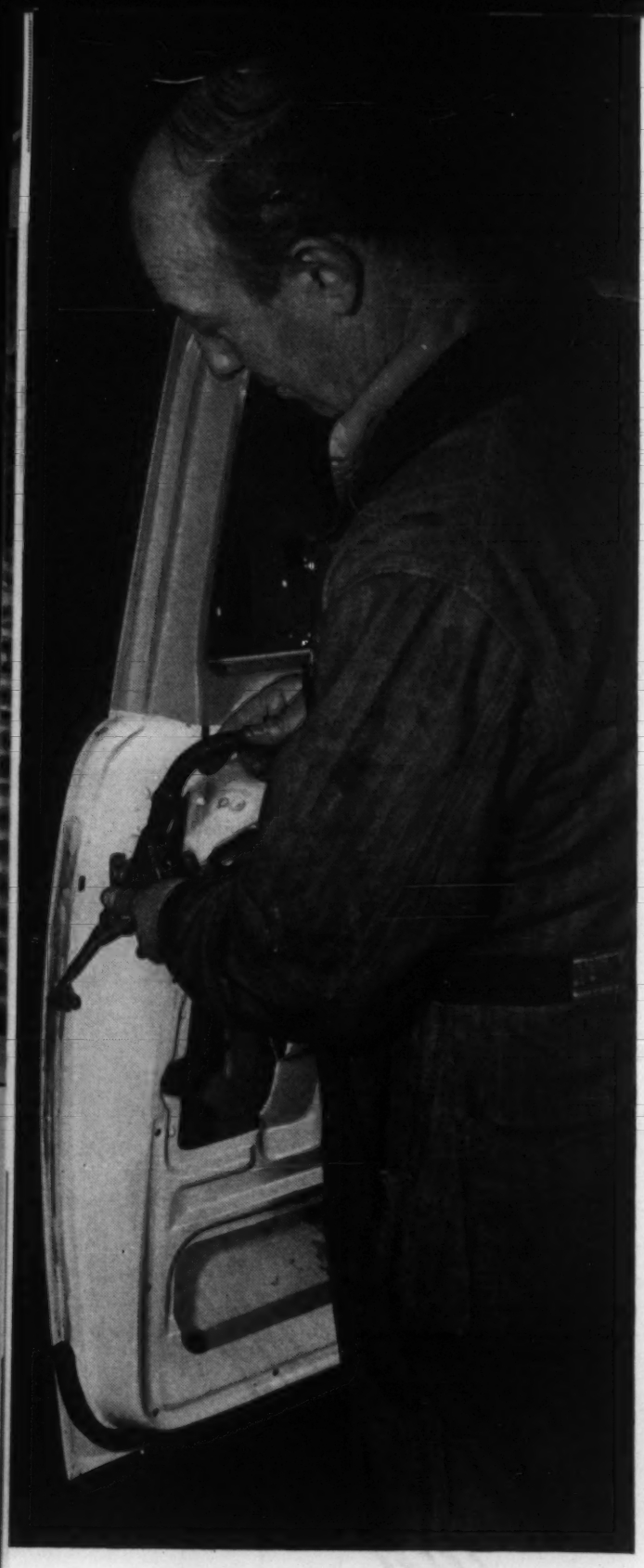
A hot box built by Northrop Aircraft, Inc. is designed for tensile tests at elevated temperatures. A phenolic-glass laminate piece is under test.



Glass-plastic rivet may consist of glass roving in a silicone or phenolic binder. Fatigue strength would be good, and there would be no differential temperature expansion when joining glass-plastic material.



Aircraft surface temperature increases with the air speed. The elevated temperatures that will be met in future aircraft demand new materials. Figures shown for USAF standard summer day.



Rapid progress in adhesives is being made to meet demands of industry. Here sponge rubber is being bonded to metal on auto door. (Minnesota Mining & Mfg. Co.)

What's New in Adhesives

Latest progress in bonding materials for plastics and metals includes (1) development of new compositions, (2) improvement of older types, and (3) better techniques of using them. These advances have widened use of both adhesives and composite materials produced by them.

by **KENNETH ROSE, Western Editor, Materials & Methods**

● ADHESIVES BONDING, a joining method that has aroused considerable interest in the past ten years, has shown considerable progress both in the formulation of the adhesives and in the techniques of using them. MATERIALS & METHODS has outlined the basic types of adhesives and their applications in past issues (see *Industrial Adhesives,* Feb. 1948, p 93). In this present article some of the newer types, and some of the more important modifying constituents for varying properties in the formulations, will be reviewed.

Rubber Base

Rubber-base adhesives, usually with a thermosetting resin added as a hardening and strengthening agent, have been the types most widely used. A whole series of types and ranges of compositions are available, using natural or synthetic rubbers in combination with various phenolics, and in a range of compositions to provide desired properties. Improvement in compositions has widened the field of usefulness of both the adhesives and the composite materials produced with them.

The synthetic rubber—resin adhesives, most versatile of the industrial bonding types, are showing gains in usage. The resin constituent is a phenolic, but the synthetic rubber may be an acrylonitrile, a chloroprene, or a thiokol. Recently the butyrals have found application here. The thiokols have been improved, and are now available in a range of types that run from the soft types, for use at low temperatures of —65 to —100 F and up to about 160 F, to the hard types that retain a good percentage of strength up to about 300 F.

Polyamides

Some of the new ingredients used in adhesives serve as extenders, some as hardeners, some as plasticizers. In many cases the same materials are used in coatings also, where the same purposes must be served. The number of plasticizers is too large to permit any comprehensive listing, but there are a few new ingredients that are chemically interesting.

A group of polyamides, chemically of the same broad classification as nylon, have been produced by General Mills, Inc. They consist of certain vegetable oils, fatty acids and amines. While they have been molded into rigid pieces in the laboratory, their important industrial applications have been in the field of thin films. Several resins are available commercially, ranging from hard, tough materials resistant to water vapor, oils, most inorganic chemicals and most organic solvents, to soft, tacky, oil- and water-resistant chemicals showing good adhesive qualities. Softening temperatures (ASTM Ball and Ring Softening Point) range from 344 F for the hardest of the resins to 110 F for the softest.

The softest and tackiest of the series (Polyamide Resin No. 100S) has been tested as a metal-bonding adhesive, and has shown good results. Its principal use, however, is as a tackifier and plasticizer for other adhesive resins, including the hard polyamide resins. It serves to increase the plasticity of other resins, and at the same time increases water-, grease- and oil-resistance of the formulation. Because of its extremely wide adhesive ability, it can be used in the formulation of coatings for metal, leather, rubber, all sorts of plastic films and paper. Formulation based on mixtures of the No. 100S resin with the border polyamide resins will heat seal at temperatures as low as 150 F. The heat seal range of these compositions is quite broad and the bonds hold well at low temperatures. Another valuable feature of the polyamide heat-sealing films is that, despite their low sealing temperature, they possess good nonblocking properties.

Other uses include the formulation of the polyamide resins with shellac as an additive or reinforcing agents to improve water resistance. Another use for the No. 100S resin which has recently attracted wide attention is based on its ability to form hard,

flexible thermosetting compositions with epoxy resins. These thermoset products, depending on the epoxy resin-polyamide resin ratio, vary from extremely hard masses with excellent shock resistance to soft, rubbery compositions. The polyamide resin imparts a high degree of flexibility to these compositions, for which reason their use is indicated as coatings for paper, metal, rubber and similar substances where a great deal of flexural strain may be involved.

The polyamide resins produced by General Mills can be used as solutions in organic solvents or as hot melts. They are also available as suspensoids in water. The solids are frequently utilized in hot-melt adhesives, while the dispersions in water and the solutions in organic solvents lend themselves to coatings and similar applications. As the suspensoids are discontinuous when applied, they must be fused to form a continuous film. The water dispersions are remarkably stable, and some of them will stand repeated freezing and thawing without separation. They are useful in production of papers that are required to possess a high degree of resistance to oil, grease, water and water-vapor.

Another group of resins useful in adhesives is the Lustrex-X-700 series of Monsanto Chemical Co. These are off-white in color, are soluble in water to produce colloidal solutions of wide viscosity range, and have good heat resistance, and good resistance to chemicals, oils and solvents. Added to adhesives, they increase tack and help to control viscosity. They are expected to find a place in the paper industry for producing a coating that will be grease- and oil-resistant.

Epoxide Resins

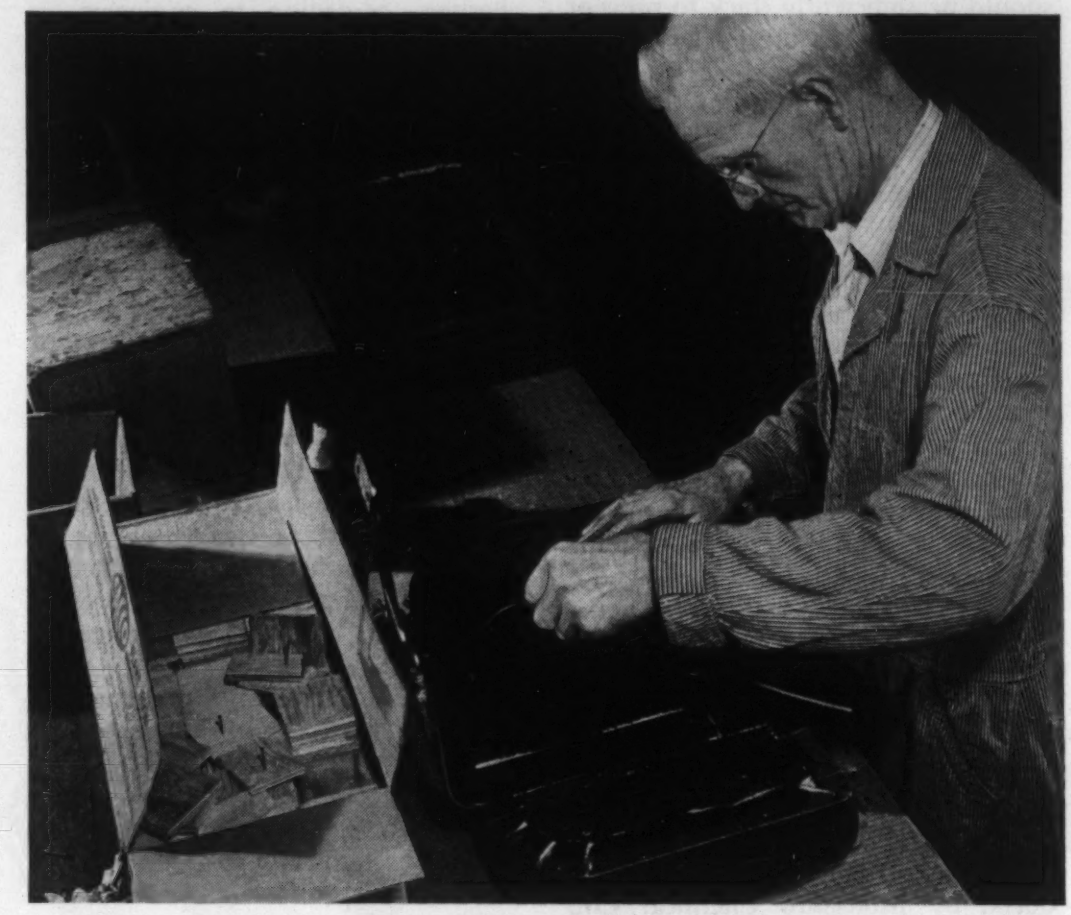
A new chemical group, the ethoxylene plastics, is finding important use in the adhesive field. Called the epoxy or epoxide resins, they are available from several sources (Shell Chemical Corp., ChemoTec Div., Eutectic Welding Alloys Corp., and Bakelite Corp.). They possess high bond strength to metals and nonmetals. Epoxy adhesives are used for bonding steel, aluminum, brass and other cuprous alloys, magnesium, wood, plastics, glass and rubber. They have also successfully joined metals to nonmetals.

Some of the properties of the epoxy adhesives are:

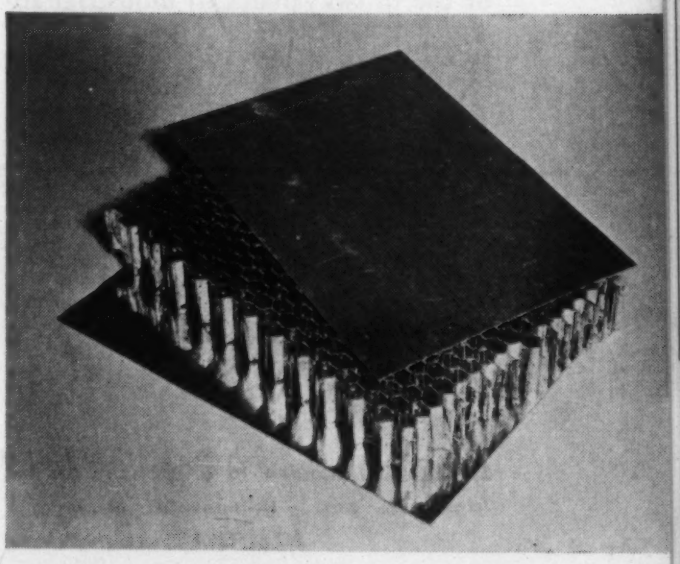
1. Excellent shelf life, usually a year or more.
2. Relatively short pot life, perhaps about 4 hr.
3. Excellent heat stability of the adhesive itself.
4. Rather poor physical strength at elevated temperatures and rather low heat distortion point.
5. Excellent bond strength at room temperatures and at low temperatures.
6. Relatively slow cure, and elevated temperatures are required for curing.

Tensile strengths of a well-made bond between aluminum sheets is of the order of 5000 psi.

Adhesives based upon the epoxy resins use a curing agent, which is mixed with the resin immediately before use. Metal surface must be clean, and free from grease or oil. A chemical etching or mechanical roughing may improve bond strength. After the adhesive is applied, the pieces are joined at once, and clamping pressure applied for about 8 hr. Bonds can be made at room temperature, but cure takes place slowly and the bond may be somewhat brittle. A practical cure cycle might be 2 hr at 165 F. The time can be shortened by raising the temperature; at 200 F, cure time can be shortened to about 45 min. Temperatures of 250 to 300 F can be used, but bond strength may be adversely affected at the higher heats. Some formulations are cured at temperatures of nearly 400 F, however.



Molded rubber mat being bonded to bottom of a jump seat in taxicab at Waters Mfg. Corp. (Minnesota Mining & Mfg. Co.)



This aluminum honeycomb section for use in aircraft assemblies is bonded together with adhesives of the ethoxylene resin type. (ChemoTec Div., Eutectic Welding Alloys Corp.)

Rubber, when being bonded by epoxy-resin adhesives, should be chemically etched over the faying surfaces by immersion in concentrated sulfuric acid for 5 to 10 min for natural rubber, or 10 to 15 min for the synthetic rubbers. Other surface treatments can be used also. Wood can be bonded without special treatment, but the adhesive used

should be sufficiently thick to prevent the wood from absorbing enough of the adhesive to starve the bond. Plastics require only removal of any mold release agent that may be on the surface of the pieces, and ordinary cleanliness.

Di-isocyanates

During the war the Germans made considerable progress in adhesive bonding, and found a way to increase bond strength. Addition of di-isocyanates to the formulation of rubber-plastics adhesives served to increase the cross-linking in the molecular structure, and, therefore, to reinforce its thermosetting nature. These di(-)isocyanates, straight(-)chain compounds having a reactive group at each end of the chain, are natural cross-linkers, and, therefore, serve to harden the adhesive and to make it thermosetting. About 10 to 15% of the compound is added to the adhesive in practice.

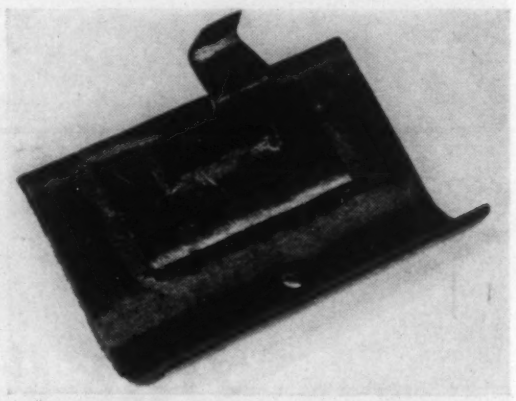
Di-isocyanates are now being produced by Monsanto Chemical Co., and E. I. du Pont de Nemours & Co., Inc.

One of the important achievements of the di-isocyanates in industrial adhesives, according to engineers, is the development of the nylon cord automobile tire. When nylon cord was first tried as a tire fabric, it was found that bonding to the rubber was unsatisfactory. Modification of the adhesive with di-isocyanates made possible an adequate bond, and nylon cord tires are now available.

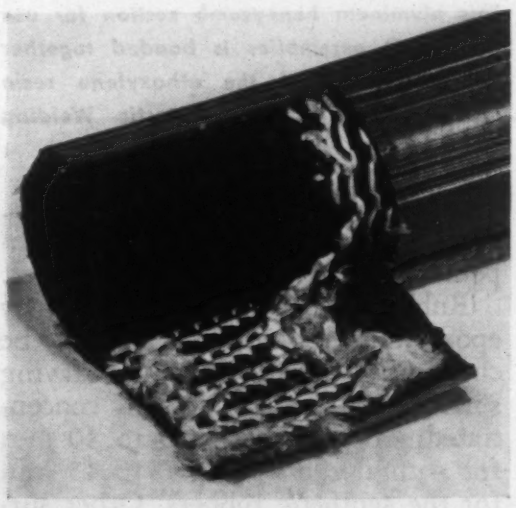
A disadvantage of the di-isocyanates is that they are irritating to mucous membranes. This is not as serious a deterrent to their industrial use as it might seem, however, for after chemical combination, the di-isocyanates are no longer objectionable and most of their uses are in combined form. In the manufacture of the chemicals themselves, precautions can be taken to avoid danger to personnel.

With the increasing interest in the di-isocyanates as industrial materials, their possibilities are being given wider recognition. The terminal groups in the chain are reactive to hydroxy-groups and to amine groups. This holds promise of producing a water-repellent coating for many proteinaceous materials. Tests have shown that excellent water resistance can be developed in leather, cotton textiles, paper, and similar materials. Nylon materials, which contain amine groups and should be capable of waterproofing by this chemical method, have not shown a satisfactory response so far.

A feature of this type of water-repellency is that the material producing the water resistance becomes a part of the base material chemically, and so it is not subject to washing out, or to removal by dry cleaning or by physical wearing-off. It does not form a coating impervious to water vapor.



Spring steel bonded to a phenolic for refrigerator part. (Minnesota Mining & Mfg. Co.)



Adhesives are put to good use bonding rayon cord to rubber in garden hose. (Minnesota Mining & Mfg. Co.)

Acrylic

One of the most interesting of the new adhesives is a light-sensitive type recently put into limited distribution by Minnesota Mining and Manufacturing Co. This bonding agent, an acrylic monomer, is polymerized by concentrated ultraviolet light or heat, or by combinations of these. It is heat-setting at temperatures of the order of 150 F, but if the application is such that the use of heat is not advisable, cure can be carried out by use of concentrated ultraviolet light alone. Use of light and heat in combination will reduce the amount of each necessary to complete the cure.

This adhesive remains clear and colorless when cured, and so finds important applications in optical items. Some of these are military goods. It is also being investigated now for such things as acrylic lenses for unbreakable spectacles, contact lenses, and prisms. It is also used for bonding acrylic plastics to glass. Since it contains no solvent, no vapor bubbles are formed between the layers of the materials being bonded. The acrylic adhesive is somewhat difficult to handle, and must be shipped under refrigerated conditions.

An increase in the use of adhesives as films or as preformed pieces has followed the recognition of the economies to be obtained by using the bonding materials in this form. Sheets of solid adhesive can be placed between layers of plywood, softened by dielectric heating, and cured without the necessity of evaporating water. There is less waste in the handling of the solid film, and cleanup is simplified. Stamping or cutting of adhesive film to preforms is the extension of this practice to workpieces for which the use of large sheets of film is impractical.

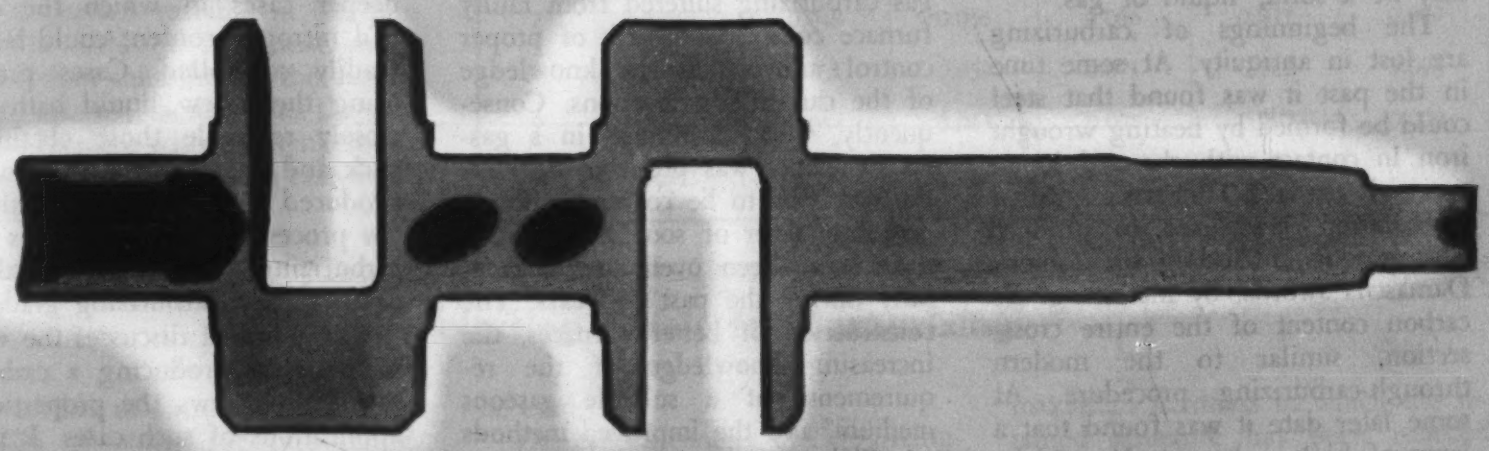
Silicones

Mica is a much-used dielectric in all sorts of electrical equipment, but the cost of the material in large sheets is quite high. Development of a silicone resin by Dow Corning Corp. to bond mica flakes to glass fabric promises a substitute for the mineral in such applications as slot liners in motors, as ground insulation, and as layer insulation in transformers. The mica-glass fabric combinations, bonded with silicone resin, can be produced as either flexible or rigid sheets or tapes. Because the silicone resin is itself heat resistant, the resulting composite material has good heat resistance and excellent dielectric strength, even under severe service conditions, including exposure to high humidity.

The same resin is used as a binder for mica splittings, producing a pasted mica sheet that can be used for wedges or segments for commutators, or for washers or spacers in which the properties of mica are desired. It is not recommended where high strength is a requirement.

Another silicone resin, used as a solution in toluene and xylene, is applied as a bonding agent for bonding mica segments into commutators. A pressure of about 1000 psi and a temperature of 350 F are recommended for curing. This agent can be used for laminating mica also.

Etched cross-section of an outboard motor crankshaft carburized to a depth of 0.040 in.



Carburizing of Steels

by John L. Everhart, Associate Editor, Materials & Methods

MATERIALS & METHODS MANUAL No. 87

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and applications.

OCTOBER 1952

Carburizing is the most common method of producing a hard surface on steel. Although this procedure has been practiced for many years, developments during the past decade have improved the reliability of the process and have led to the increased use of the gas and liquid carburizing methods. This manual discusses:

- ***Carburizing methods***
- ***Heat treatment after carburizing***
- ***Properties of carburized steels***
- ***Causes of defects***
- ***Applications***

Introduction

In many steel applications, it is desirable to employ a material having a hard surface backed by a strong and ductile core. There are various methods of accomplishing this objective, the oldest being carburizing.

Carburizing is defined by the American Society for Testing Materials as "A process of case hardening in which carbon is introduced into a solid iron-base alloy by heating above the transformation temperature range while in contact with a carbonaceous material which may be a solid, liquid or gas."

The beginnings of carburizing are lost in antiquity. At some time in the past it was found that steel could be formed by heating wrought iron in contact with charcoal in an open pit furnace. This process, called cementation, was used to produce cutting tools, including the famous Damascus swords, by increasing the carbon content of the entire cross-section, similar to the modern through-carburizing procedure. At some later date it was found that a layer of high carbon steel could be formed in this process by limiting the time of exposure of the iron to the charcoal and the carburizing process began.

This process developed into the procedure known today as pack or box carburizing. Essentially the same procedure as that practiced by the blacksmith many years ago, modern pack carburizing takes advantage of improvements in the carburizing compounds, better furnace control and proper selection of steels to produce an engineering material with controlled properties.

In the latter part of the nineteenth century, it was determined that steels could be carburized by exposure to a relatively unstable carbon-bearing gas and the first patent was issued covering such a process. However, for many years gas carburizing suffered from faulty furnace construction, lack of proper control and insufficient knowledge of the carburizing reactions. Consequently, work carburized in a gaseous medium was prone to be non-uniform and to be covered with an unsightly layer of soot. Such conditions have been overcome, particularly during the past 15 years. The construction of better furnaces, the increasing knowledge of the requirements of a suitable gaseous medium, and the improved methods of control have resulted in the development of a process which yields uniform work, if proper precautions are taken. Consequently, gas carburizing is rapidly replacing pack carburizing in many organizations.

Liquid carburizing, the most recent of the carburizing methods, is a development of the cyanide process. Cyaniding, as the process is called, consists of heating the steel in contact with a suitable sodium cyanide bath. The case formed contains both carbon and nitrogen and is normally rather shallow and harder than the usual carbon case. The proportions of carbon and nitrogen in the case depend on the composition and the temperature of operation of the bath. The discovery of the possibility of adding compounds to increase the activity of the bath led to the production of deeper cases in which the carbon and nitrogen content could be more readily controlled. Cases produced using these new liquid baths more closely resemble those obtained in pack and gas carburizing than those produced in the cyanide bath, and the process became known as liquid carburizing. This process is also replacing pack carburizing gradually.

This Manual discusses the various methods of producing a carburized case and reviews the properties and applications of such cases. It is concerned only with carburizing and, therefore, excludes carbonitriding, nitriding and the various proprietary procedures for the case hardening of steel.

Pack Carburizing

Carburizing with solid materials has been practiced for many years, originally in open fires and later with the parts to be carburized packed in boxes. Charcoal derived from various forms of organic matter or coke is used to furnish the carbon necessary for the process.

In modern operations, carburizing compounds are based usually on hard wood charcoal and coke. All contain carbonates as energizers or catalysts. Although there are numerous proprietary compounds on the market, they are all basically similar and there is little difference in their effects.

The usual compound contains from 70 to 90% charcoal, from 5 to 20% energizer in the form of barium or sodium carbonate, and from 4 to 6% binder, which may be water, oil, molasses or tar. Coke is frequently used in place of a portion of the charcoal, the purpose of such an addition being to make the compound more porous, less friable, thus reducing the formation of fines, and less combustible. Coke also has better heat conductivity than charcoal. These properties have been responsible for the development of the modern "non-burning" compounds which contain no charcoal. Such compounds are prepared by mixing the energizer with a suitable coal before coking. During the coking operation it is claimed that the energizer enters the pores of the coke and a more uniform compound is produced than can be obtained by mechanical mixtures.

Barium carbonate is preferred generally as the energizer because the alkali carbonates yield oxides upon decomposing which are quite corrosive to the carburizing boxes. However, some compounds contain a small quantity of sodium carbonate in addition to the barium carbonate because the former decomposes at a lower temperature and certain advantages are claimed for this effect.

In both the solid and gaseous carburizing procedures, carburizing the steel depends on the reaction of a gas with the steel surface to release active or atomic carbon, which may either be absorbed in the steel or be converted into molecular carbon and appear on the surface as soot. The temperature must be above the critical range of the steel for successful carburizing, because the steel must be in the austenitic form to absorb sufficient carbon. The solubility of carbon in ferrite is quite low.

The carbon that is absorbed by the steel diffuses inward at a rate depending on the diffusion coefficient, the temperature, and the carbon potential

at the surface. Although certain elements, if present in sufficient quantity, affect the rate of diffusion, this rate appears to be independent of composition for the carbon and low alloy steels usually employed for carburizing. In other words, diffusion in all of the usual carburizing steels will proceed at approximately the same rate. The carbon potential is the difference between the quantity of carbon which is soluble in the austenite at the carburizing temperature and the original carbon content of the steel. The effect of alloying elements on the carbon potential is still under investigation.

The carburizing temperature is the most important variable in the process. The diffusion coefficient, maximum carbon solubility in the austenite and rate of reaction with the steel surface increase with the temperature while the time for a given case depth decreases.

Case Depth Depends on Time and Temperature

(Values of case depth in in. as determined by F. E. Harris, Dow Furnace Co.)

Time at Heat Hr	Temperature, F					
	1550	1600	1650	1700	1750	1800
1	0.015	0.018	0.021	0.025	0.029	0.033
2	0.021	0.025	0.030	0.035	0.041	0.047
3	0.026	0.031	0.036	0.043	0.050	0.057
4	0.030	0.036	0.042	0.050	0.058	0.066
5	0.034	0.040	0.047	0.056	0.065	0.074
6	0.037	0.044	0.051	0.061	0.071	0.081
7	0.040	0.048	0.056	0.066	0.077	0.087
8	0.042	0.051	0.059	0.071	0.082	0.093
9	0.045	0.054	0.063	0.075	0.087	0.099
10	0.047	0.057	0.066	0.079	0.092	0.104

Selecting Steels for Carburizing

A number of factors influence the selection of steels for carburizing. Basically, such steels must have the proper characteristics to permit them to absorb carbon at a reasonable temperature and rate, be hardenable without excessive distortion, and be heat treatable to obtain the desired core properties.

Carburizing grades of carbon steels are generally coarse grained silicon killed steels. Fine grained carbon steels tend to be abnormal and do not carburize satisfactorily. However, with the advances in steel making practice in recent years, this tendency toward abnormality in fine-grained carbon steels is being overcome. In general, fine-grained alloy steels are preferable to coarse-grained because they do not show excessive grain growth at the carburizing temperatures, develop excellent toughness on direct quenching, and are not so prone toward distortion as coarse-grained steels.

Other considerations in the selection of a steel are the quenching medium and the type and magnitude of the stresses to which the finished part will be subjected in service. If surface hardness is the principal requirement and the properties of the core are not too critical, carbon steels are generally used. If high strength and toughness, together with deep hardening, are required of the core, alloy steels must be used.

The carbon content of carburizing steels is generally limited to a maximum of 0.04%. However, higher carbon steels are sometimes carburized, usually with rather light cases for special applications.

Nickel, chromium and molybdenum are the alloying elements used most frequently. Nickel increases the strength and toughness of the core, but in high nickel steels retention of austenite in excessive quantity can lower the wear resistance of the case. Chromium, which is a carbide former, increases the hardness and wear resistance of the case and also strengthens the core. Molybdenum, also a carbide former, increases the hardness of the case but is valuable, particularly because it assists in the retention of hardness to higher temperatures than occurs in steels not containing this element.

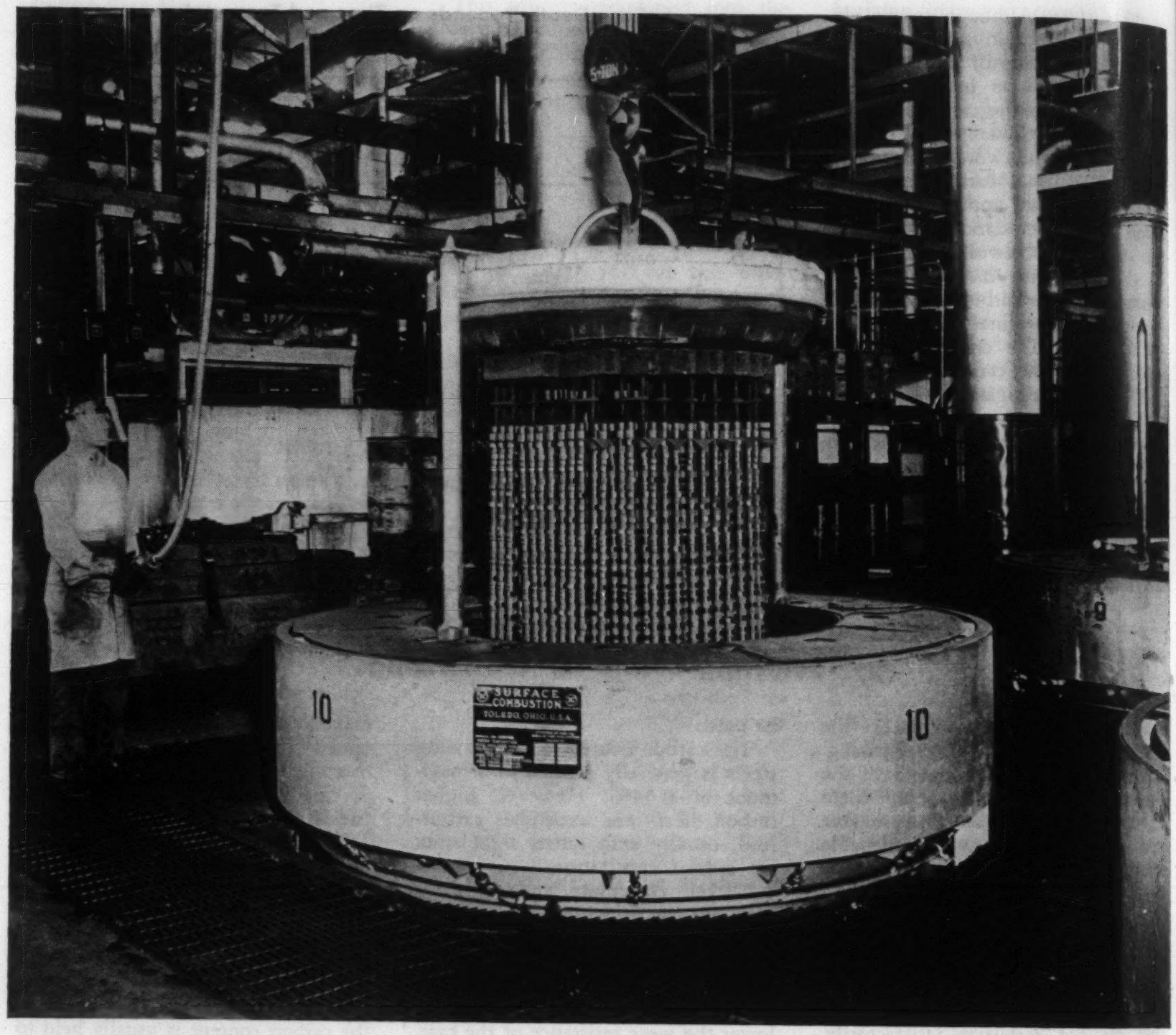
In selecting the steel, the service conditions also must be considered. For compressive stresses under static loads, the case must have sufficient depth and the core must be strong enough to resist surface deformation. If bending stresses are involved, it is necessary to sacrifice some hardness in the case and modify the core properties to obtain the best resistance to this type of stress.

One of the major requirements for many carburized parts is abrasion resistance. This requires a case of maximum hardness in which the retained austenite has been reduced to a minimum to limit flow. A depth of case sufficient to give reasonable life is also required.

With considerations such as these in mind, some general comments on suitable steels can be made. In the selection of carbon steels, those of the AISI 1000 and 1100 series are generally employed. Since there is a possibility of brittleness in the fully quenched core of high carbon steels, the carbon content is usually held to a maximum of 0.25%.

Moderately alloyed steels containing up to 2% of alloying elements are most widely used in applications where oil-quenching is required. In order to develop high core properties upon heat treatment, carbon contents up to 0.40% are sometimes employed. Among the commonly used alloy steels in the moderately alloyed group are the AISI 3100, 4000, 4100, 5100, 6100, 8000, 8600 and 8700 steels. Carbon contents can range as high as 0.45%, although for fine grained steels it is preferable to limit the carbon content to 0.25%.

In the more highly alloyed steels, AISI 2300, 2500, 3300, 4300, 4600, 4800 and 9300 steels are employed with the maximum carbon content held to approximately 0.25% because of the high hardenability of these materials.



Charging a pit-type carburizing furnace with 4800 lb of automotive cam shafts. Radiant tubes and a recirculating fan are used to circulate enriched cracked gas through the furnace at 1700 F. (Surface Combustion Corp.)

In solid carburizing the reaction depends on the formation of carbon monoxide by union of the hot carbon with oxygen which has been entrapped in the box. This carbon monoxide then reacts with the steel surface to form active carbon, soot and carbon dioxide. The basic reactions follow:

$$2C + O_2 \rightleftarrows 2CO \quad (1)$$

$$2CO + Fe \rightleftarrows C_{[active]} + CO_2 \quad (2)$$

$$CO_2 + C \rightleftarrows 2CO \quad (3)$$

In reaction (2), part of the carbon can be converted to soot and deposited on the steel surface.

Since carbon monoxide is quite stable at high temperatures, the rate of transfer of carbon to the steel is low, one of the controlling factors being the rate at which carbon dioxide is reformed in the reaction. The carbon dioxide formed will react with solid carbon to form additional carbon monoxide, but the reaction will stop when equilibrium is reached at the given temperature. In modern practice, the reaction is accelerated by the use of carbonate catalysts, usually called energizers.

The function of the energizer is to force the reaction in the direction favoring the formation of carbon monoxide. Although the exact mechanism is disputed, the following reactions indicate a possible manner in which this occurs:

$$BaCO_3 + C \rightleftarrows BaO + 2CO \quad (4)$$

$$BaO + CO_2 \rightleftarrows BaCO_3 \quad (5)$$

This mechanism is favored by some authorities in the field but rejected by others. The latter believe that the only function of the energizer is to catalyze the reaction by some means which is not understood at present. In their opinion, the energizer remains unchanged during the process. Whatever the mechanism, it has been established that the rate of supply of active carbon to the steel surface is accelerated—by the use of energizers.

Carburizing Boxes

One of the important factors in successful pack carburizing is the box. Since the box and contents must be heated from room temperature to the carburizing temperature, it is advantageous to use the smallest and thinnest container possible. Although cast boxes have been used extensively, in recent years boxes made of rela-

tively thin sheet, welded in the proper form, have been used increasingly. These boxes may have ribs for stiffening since they require sufficient strength for handling at the carburizing temperature.

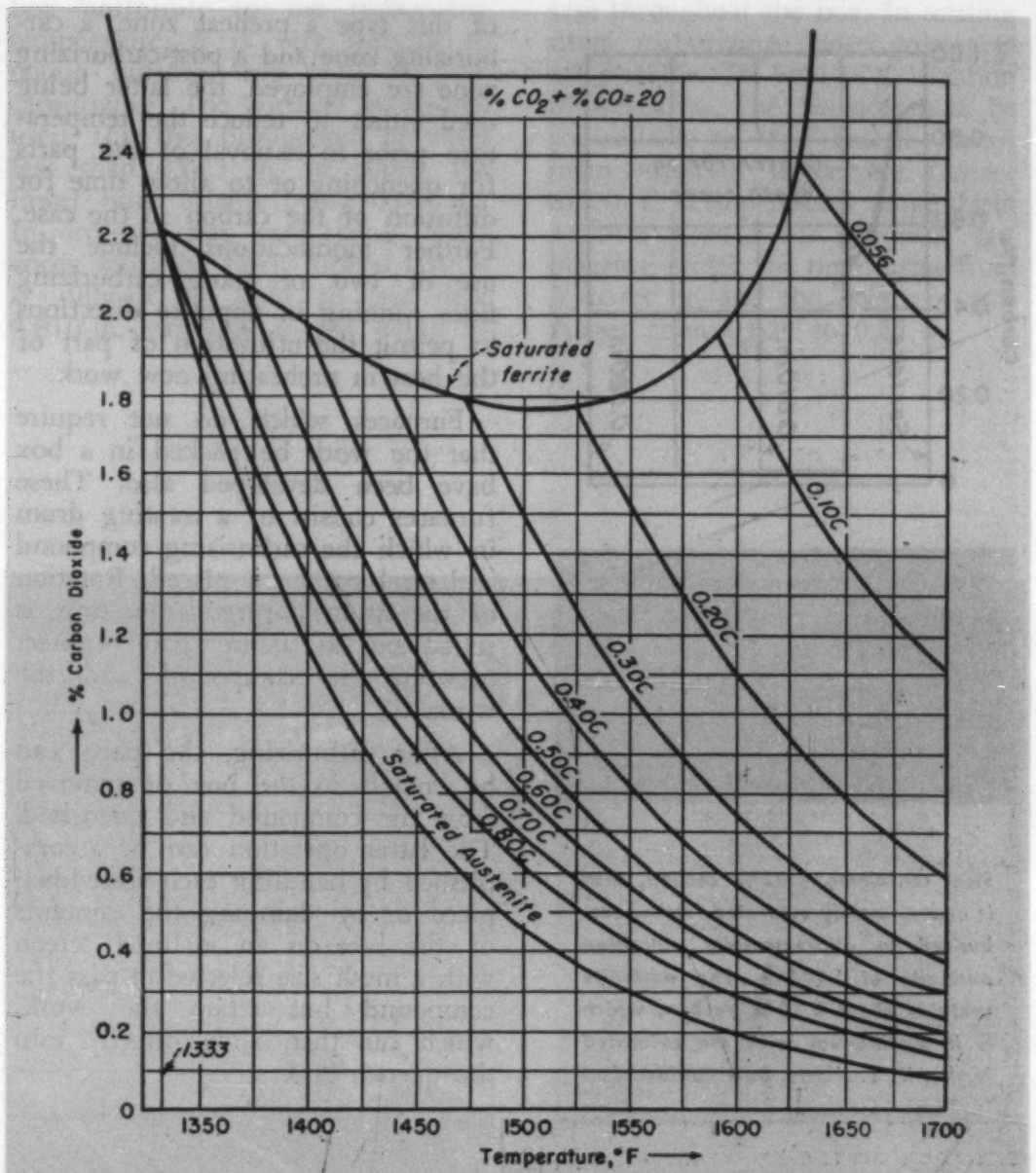
In order to minimize the carburizing of the container and thus reduce the life of the box, modern practice tends toward the use of high nickel steels or nickel-chromium alloys for the boxes. These materials suffer less attack from the carburizing gases than the lower alloy steels or cast irons used previously. However, the use of such containers necessitates the careful control of sulfur both in the carburizing compound and in the furnace atmosphere, if the furnace is fuel fired, for high nickel alloys are very susceptible to attack by sulfur at high temperatures. The lids must fit fairly tight to prevent excessive entry of air to the container and consequent rapid destruction of the carburizing compound. On the other hand, escape of spent gas from the container is advantageous to permit circulation of active gas around the work, and the early practice of sealing the boxes with clay has been discontinued in many organizations.

Packing the boxes is an operation requiring considerable care to assure contact between each individual piece of steel and the carburizing compound. Although such contact is not absolutely necessary, non-uniform cases can result if such a procedure is not carried out. The mesh size of the compound is important. It must be fine enough to permit entry into holes and between gear teeth but not so fine that it interferes with free circulation of gases. Generally, compounds ranging from 3 to 6 mesh size are used commercially. There must be sufficient compound in the box to assure complete coverage of the work even though the compound settles during the carburizing cycle. The packing operation is dirty and can be quite expensive at present labor rates.

Various paste and powder carburizers have been developed for special applications. They are particularly valuable where it is desirable to harden only a portion of the surface.

Selective Carburizing

In order to protect those portions of the surface which are not to be carburized, some means must be employed to prevent contact of that area with the carburizing compound. This is commonly accomplished by plating a layer of copper on the part, either selectively, by masking the areas which are not to be plated, or completely covering the surface. In the latter case, the copper layer must be removed from the surfaces to be carburized, and this is frequently done during the final machining operation which precedes carburizing. Various proprietary stop-off compounds have been developed also to prevent carburization of portions of the surface. These are used to a more limited extent than copper plating, particularly in the handling of small volumes of work where it would be uneconomical to install copper plating equipment.

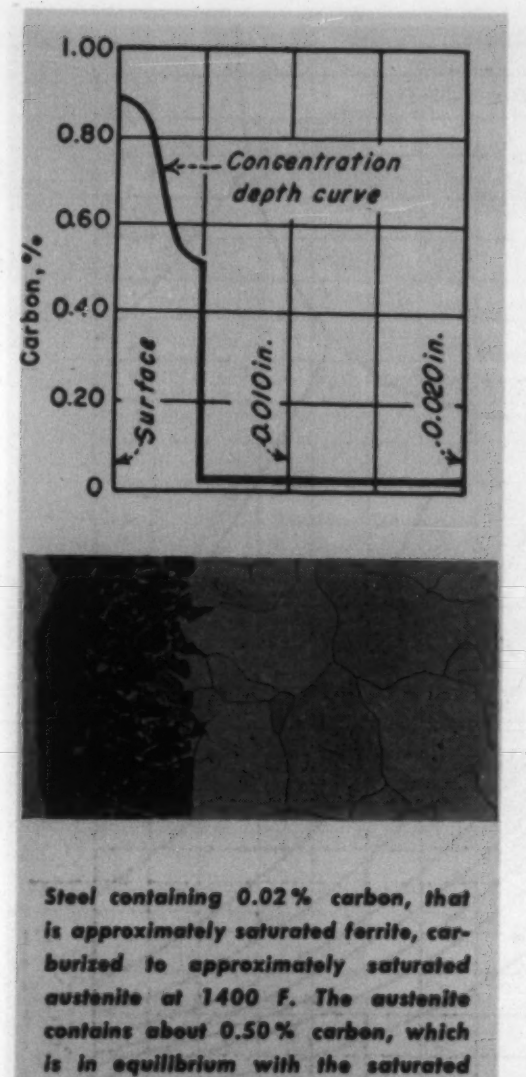


Typical equilibrium curves for a plain carbon steel for an atmosphere in which % CO + % CO_2 = 20. If such an atmosphere contained 0.4% CO_2 and 19.6% CO, for example, it would be in equilibrium with a steel containing 0.6% carbon at 1600 F. This atmosphere would be carburizing toward steels containing less than 0.60% carbon and decarburizing toward those containing more than 0.60% carbon. (F. E. Harris, Dow Furnace Co.)

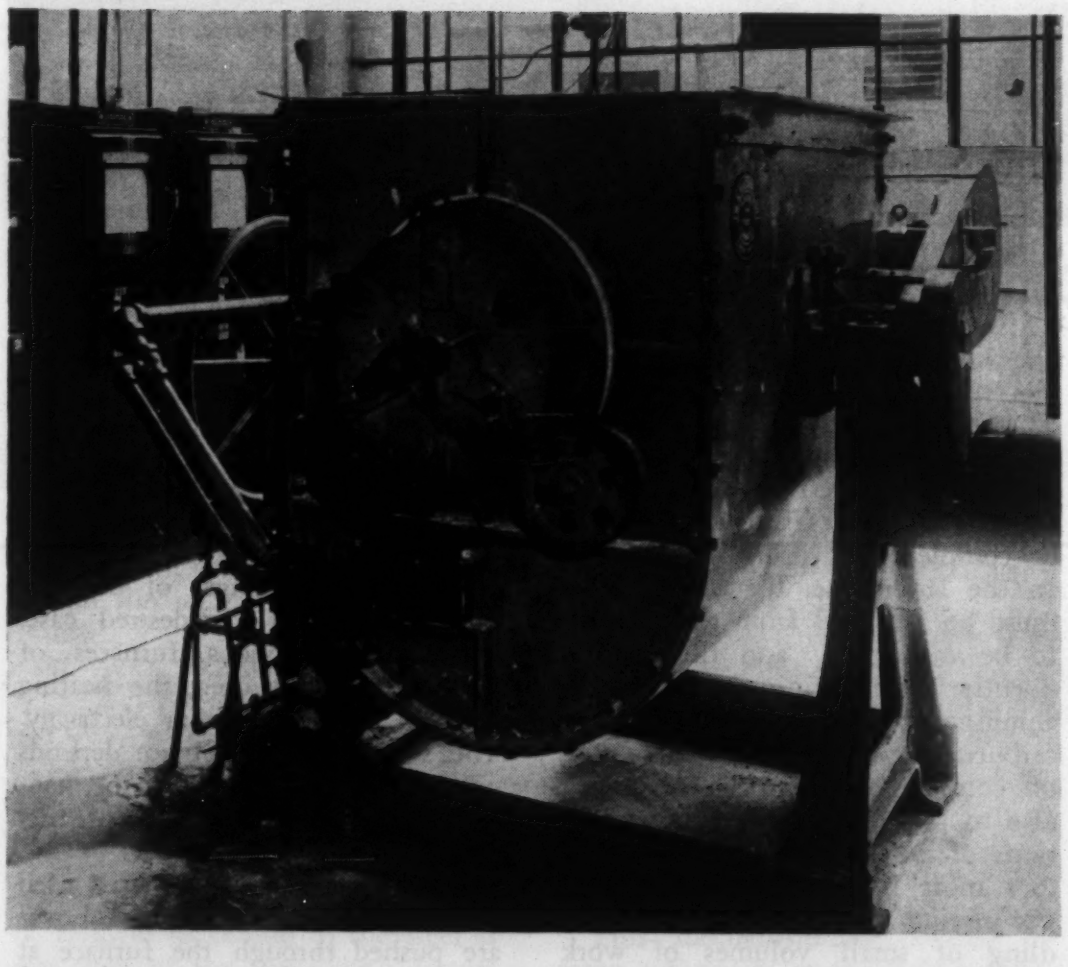
Furnaces

The principal requirement of a furnace for pack carburizing is the ability to maintain a uniform temperature for the length of time required to obtain the desired case. Batch or continuous furnaces of various types are used, the heating medium being oil, gas or electricity. The selection of a furnace depends on the volume of work to be handled and the relative cost of fuel or electricity in the area.

In the continuous furnace, used for large volume work, the boxes are pushed through the furnace at the desired rate to achieve satisfactory case depth. In some furnaces



Steel containing 0.02% carbon, that is approximately saturated ferrite, carburized to approximately saturated austenite at 1400 F. The austenite contains about 0.50% carbon, which is in equilibrium with the saturated ferrite. (F. E. Harris, Dow Furnace Co.)

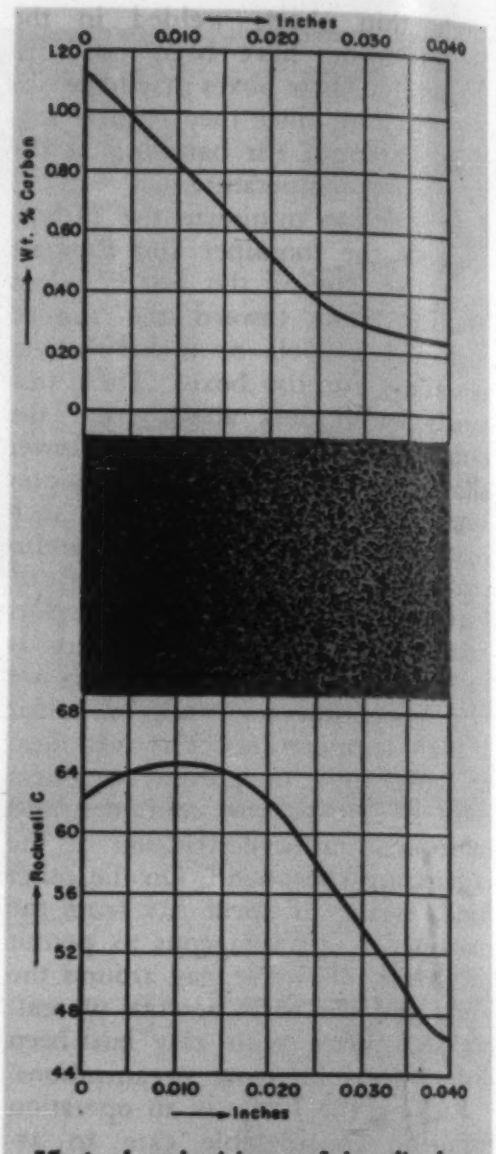


Rotary furnace for solid compound or gas carburizing small parts which can be tumbled slowly. (W. S. Rockwell Co.)

of this type a preheat zone, a carburizing zone and a post-carburizing zone are employed, the latter being used either to reduce the temperature prior to removal of the parts for quenching or to allow time for diffusion of the carbon in the case. Further modifications include the use of two or more carburizing lines running in opposite directions to permit the utilization of part of the heat in preheating new work.

Furnaces which do not require that the work be packed in a box have been developed also. These furnaces consist of a rotating drum in which the carburizing compound and steel parts are placed. Rotation of the drum during carburizing is relied on to assure good contact between the compound and the work.

After carburizing, the parts can be cooled in the box or removed from the compound and quenched. The latter operation can be accomplished by handling each individual piece or by dumping the contents of the box on an inclined screen with a mesh size selected to pass the compound but retain the work, which can then slide directly into the quench tank.



Effect of carburizing a 1-in. dia bar of 0.24 carbon, 1.32% manganese steel: (a) Variation in carbon content from surface toward center of bar after gas-carburizing 2¼ hr at 1650 F; (b) Structure of same portion of annealed bar, (original magnification 75X); (c) Hardness of same portion of bar after oil-quenching from 1500 F. (F. E. Harris, Buick Motor Div. Reproduced by permission from A. C. Guy, "Elements of Physical Metallurgy", pub. by Addison Wesley Press, Cambridge, Mass.)

Carburizing Compound Treatment

After use, the compound is mixed with new material to replace losses. Although it is frequently mentioned that small additions of energizer are made at intervals, this is seldom done in actual practice. The old carburizing compound must be regenerated between runs by allowing it to stand for several hours in air. Various explanations have been advanced for the ability of the compound to be regenerated by this procedure, but the most logical appears to be adsorption of air by the

charcoal. After use, the compound is screened to remove the extreme fines and obtain a material sufficiently coarse to permit free circulation of the carburizing gas around the work.

Case Depth

Because of the rather slow rate of heating and the impossibility of raising the entire contents of the box uniformly to the carburizing temperature, it is very difficult to obtain uniform thin cases by pack carburizing. The method is seldom used for the production of cases less than 0.025 in. in depth, the lower limit usually being 0.040 in. In ordinary box carburizing, tolerances must be fairly liberal, for it is difficult to hold to less than 0.010-in. variation in the depth of case throughout the box. In rotating drum carburizing, closer tolerances are possible. To hold to a variation of 0.010 in., the furnace must be controllable to 10 F and the maximum variation inside the furnace to 20 F. Temperatures range from 1550 to 1750 F for the usual carburizing cycles, the time varies from 3 to 48 hr, and the depth of case ranges from 0.025 to 0.25 in.

Gas Carburizing

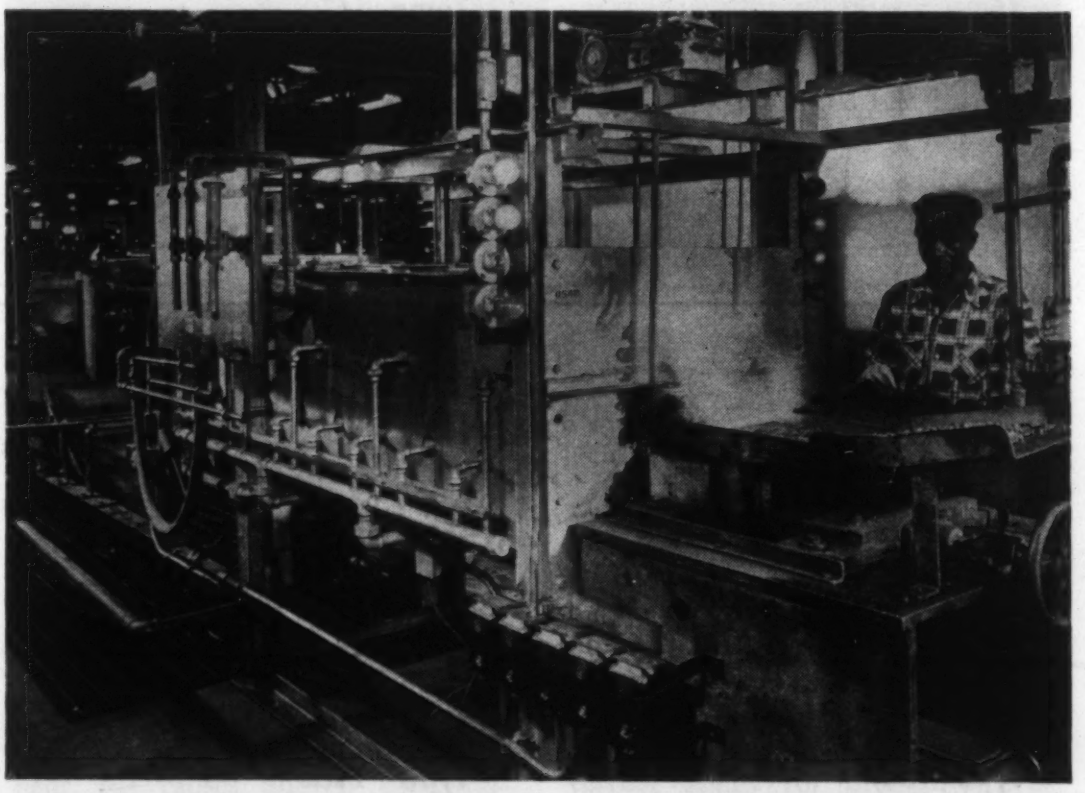
During the past ten years, improvements in control have led to an expanded use of gas carburizing, and this process is replacing pack carburizing in an increasing number of applications.

The mechanism of gas carburizing is similar to that described previously. The steel is heated in contact with carbon monoxide and/or a hydrocarbon which is readily decomposed at the carburizing temperature. This hydrocarbon can be methane, propane, natural gas, vaporized fluid hydrocarbon, or a similar material. The higher hydrocarbons break down at the carburizing temperatures into methane, soot and hydrogen. Thus, after the deposition of soot, all react essentially in the same manner. Since carbon monoxide is present also in some of the carburizing atmospheres, although it is of minor importance in others, the basic reactions to be considered are:

$$Fe + 2CO \rightleftarrows C_{[active]} + CO_2$$
$$Fe + CH_4 \rightleftarrows C_{[active]} + 2H_2$$

Some of the carbon enters the steel while part may be deposited as soot on the surface of the work.

Carbon monoxide is a less effective agent in gas carburizing than methane. In a carbon monoxide atmosphere, only a little carbon dioxide need form before equilibrium is reached at carburizing temperatures and the reaction stops. If methane is used, the reaction can proceed until the furnace atmosphere contains 99% hydrogen before equilibrium is reached. Further, carbon monoxide becomes more stable and thus less reactive as the temperature is increased, while methane becomes less stable and more reactive under the same conditions. Because of these factors, at a given temperature it has been shown that methane has many times as much carbon available for carburizing as carbon monoxide.



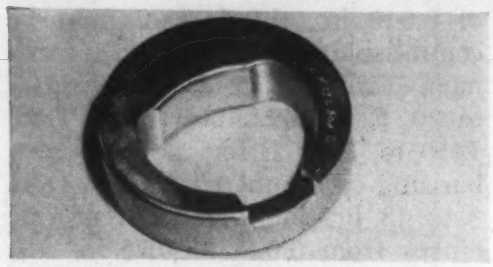
Reciprocating-hearth furnace installed at the Chicago Screw Co. for the light case carburizing of small parts. (American Gas Furnace Co.)

The rate of absorption of carbon is dependent on its solubility in the steel at a given temperature. If a suitable atmosphere is present that is, one capable of supplying sufficient carbon—the surface carbon content of the steel will be that corresponding to saturated austenite at the carburizing temperature. This value is shown by the A_{cm} line in the iron-carbon diagram for the steel in question and varies with the composition of the steel and the temperature. If the carbon potential is greater than the solubility limit of the steel at the selected temperature, absorption will proceed at a definite rate until the solubility limit is reached. No excess carbon will be absorbed.

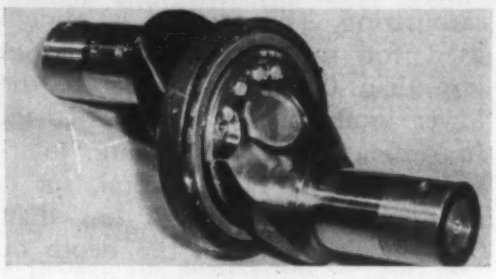
Diffusion of the carbon into the steel will tend to reduce the carbon at the surface layer, and the function of the carburizing atmosphere is to replace the carbon in the surface layer to maintain the condition of saturated austenite in that layer. This is accomplished best by maintaining a carburizing potential in the atmosphere above the solubility limit of the steel. The case depth is a function only of the time and temperature and is shown in the accompanying table for a number of conditions. After carburizing for sufficient time to obtain the desired case depth, a short diffusion cycle is necessary to obtain the desired carbon content in the surface layer.

In an alternate procedure, the carbon potential is maintained at or below the solubility limit of the

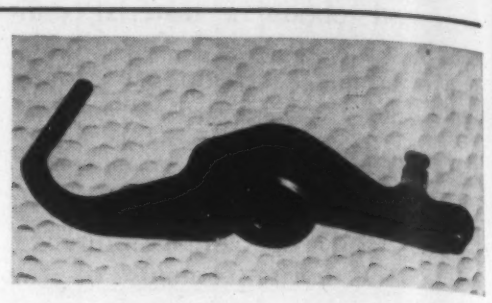
Some Typical Carburizing Applications



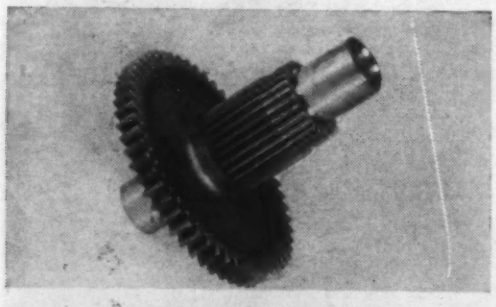
Part Counter-weight bushing
Steel AMS 6263
Case Depth 0.055 to 0.065 in.
Carburizing Furnace
Type Gas
Atmosphere Cracked liquid
Temp 1700 F
Time 12 hr
Subsequent Heat Treatment Hardened and tempered
(Courtesy Wright Aeronautical Div.)



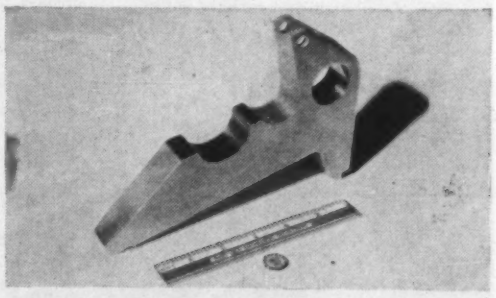
Part Crankshaft center
Steel AMS 6260
Case Depth 0.035 to 0.045 in.
Carburizing Furnace
Type Gas
Atmosphere Cracked liquid
Temp 1700 F
Time 6 hr
Subsequent Heat Treatment Hardened and tempered
(Courtesy Wright Aeronautical Div.)



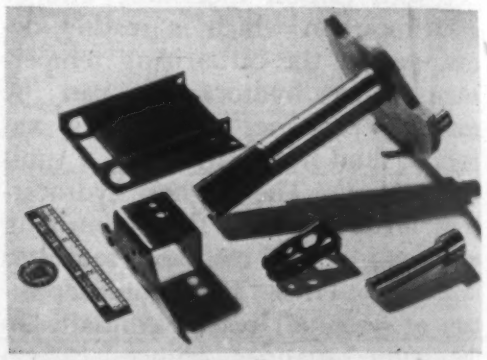
Part Upper locking lever assembly
Steel Hub, SAE 1113, cold drawn, Lever, SAE 1010
Case Depth 0.005 in.
Carburizing Furnace
Type Immersed electrode salt bath
Medium Water soluble salts
Temp 1640 F
Time 20 min
Subsequent Heat Treatment None, oil-quenched from carburizing furnace
(Courtesy A. B. Dick Co., and American Cyanamid Co.)



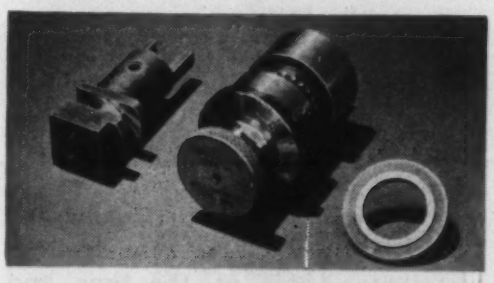
Part Impeller drive gear and pinion
Steel AMS 6263
Case Depth 0.025 to 0.035 in.
Carburizing Furnace
Type Gas
Atmosphere Cracked liquid
Temp 1700 F
Time 4½ hr
Subsequent Heat Treatment Hardened and tempered
(Courtesy Wright Aeronautical Div.)



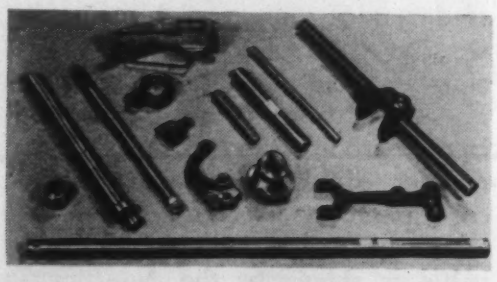
Part Cam
Steel AISI C1015
Case Depth 0.045 in.
Carburizing Furnace
Type Pack
Medium Solid compound
Temp 1675 to 1700 F
Subsequent Heat Treatment Quenched from 1400 to 1425 F into water
(Courtesy Westinghouse Electric Corp.)



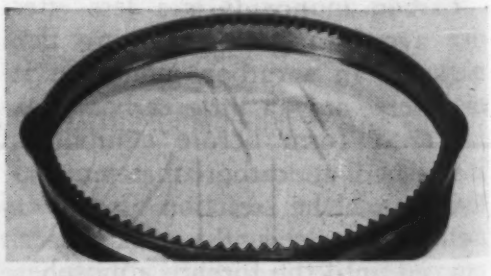
Part Central crankshaft
Steel AISI 416
Case Depth 0.020 to 0.025 in.
Carburizing Furnace
Type Gas
Temp 1795 to 1830 F
Subsequent Heat Treatment Tempered at 345 F
(Courtesy Westinghouse Electric Corp.)



Part Machine parts
Steel SAE 4120
Case Depth 0.028 in.
Carburizing Furnace
Type Electrode salt bath
Medium Water soluble salts
Temp 1600 F
Time 3 hr
Subsequent Heat Treatment Quenched in oil at 120 F, tempered at 350 F
(Courtesy A. F. Holden Co.)



Part Industrial machine parts
Steel AISI 1020
Case Depth 0.030 in. (effective depth)
Carburizing Furnace
Type Gas, vertical retort
Atmosphere Cracked liquid or natural gas
Temp 1700 F
Time 4 hr
Subsequent Heat Treatment None, directly quenched from carburizing furnace
(Courtesy Hevi-Duty Electric Co.)



Part Rear intake and exhaust cam
Steel AMS 6260
Case Depth 0.055 to 0.065 in.
Carburizing Furnace
Type Gas
Atmosphere Cracked liquid
Temp 1700 F
Time 12 hr
Subsequent Heat Treatment Hardened and tempered
(Courtesy Wright Aeronautical Div.)

steel. Although the mechanism is similar to that described above, diffusion occurs at a slower rate, since the carbon potential or pressure is lower, and it is claimed by some authorities that carburizing in this manner will take from 30 to 50% longer than in the method described previously.

Of the other gases which can be present in the furnace, carbon dioxide is an active decarburizer and can also oxidize the surface. Its activity is determined by the ratio of carbon monoxide to carbon dioxide, and this ratio varies with the temperature. It is impossible to obtain a single mixture of these two gases which will carburize at all temperatures. Hydrogen is a decarburizer, but the action is weak in the presence of methane. Water vapor is a decarburizer whose action depends on the composition of the gas. Nitrogen is practically inert.

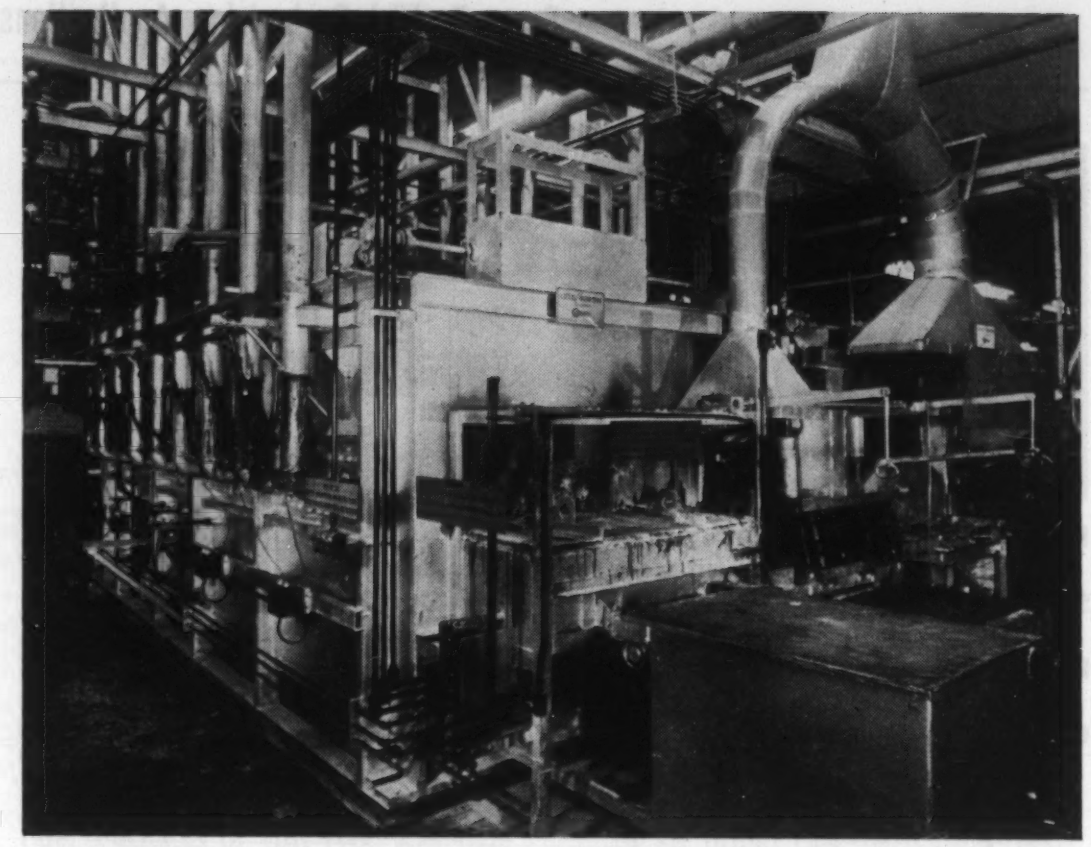
In the early days of gas carburizing, natural gas, manufactured gas or the like was passed directly into the furnace and permitted to react with the steel at a suitable temperature for a period of time which was determined by experience to give the depth of the case desired. Forced circulation was not used, sooting was a major problem, and results were frequently very erratic.

In the modern procedures the dependability has been improved by adequate sealing of the furnaces to prevent access of air and by forced circulation of the gas. It has been found that uniform cases over the entire charge can be obtained only if leakage of air into the furnace is prevented. Thus, furnaces are operated under a positive gas pressure of a fraction of an inch to 10 in. of water. Frequent checks are made to detect leaks.

Raw gases have been replaced frequently with prepared gases. These consist of a stable carrier gas containing a relatively unstable carburizing gas, usually a hydrocarbon, in a suitable dilution to provide active carbon at the steel surface at the desired rate without excessive sooting.

The carrier gas serves also to purge the furnace before admitting the carburizing gas and to maintain the desired pressure within the furnace.

The carrier gas can be prepared by a catalytic reaction between fuel gas and air. If an endothermic reactor is used, the more popular type, the gas consists essentially of nitrogen, carbon monoxide and hydrogen with low percentages of carbon dioxide and water vapor. If an exothermic reactor is used, the content of carbon dioxide and water vapor in the prepared gas is high enough to require removal. Alternately, a completely cracked ammonia atmosphere can be used as a carrier gas.



Installation for the carburizing of automotive parts at Chevrolet. (Loftus Engineering Corp.)

The rate of flow of the gas affects the rate of surface reaction. A stagnant gas causes uneven carburization, while streamline gas flow is less effective than turbulent flow, for the latter assists in scouring the surface and supplying fresh gas to replace that which has reacted with the steel.

The composition of the carburizing gas is extremely important, for it influences the rate at which the gas reacts to supply active carbon, the rate of formation of soot, and the physical nature of the soot. The formation of soot not only spoils the appearance of the work but interferes with carburizing and can cause the formation of an uneven case. Sooting occurs only when the rate of formation of the carbon exceeds the rate at which it is absorbed by the steel, and can be controlled by a number of methods.

In practice, the carrier gas is admitted to the furnace for purging and to obtain the desired pressure. By adding the carburizing gas in continuous furnaces after the furnace temperature reaches about 1300 F, sooting is reduced. In batch furnaces, the mixed gas is generally added immediately.

Among methods which have been employed to prevent excessive sooting are (1) use of the lowest possible concentration of carburizing gas; (2) preheating the circulating gas; (3) in a continuous furnace having zones for preheating, carburizing and diffusion, the gas being passed over radiant heater tubes in the bottom of the furnace, at which point soot is deposited, before coming into contact with the work; and (4) using a rotary retort furnace with the object of removing the soot from the work by the rubbing action of one piece of steel against another. Because the work can be abraded or scratched in this type furnace, it is less frequently used for gas carburizing than the other types of furnaces.

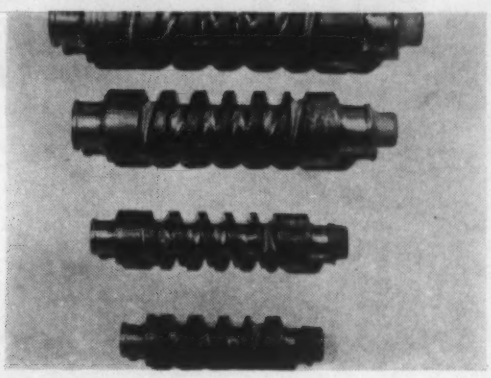
An important advantage of gas carburizing is the fact that the composition of the gas and the rate of flow can be adjusted to obtain the desired carbon content and depth of case. Such control is essential for satisfactory results.

The usual methods of control consist of carburizing a test piece with the work and examining it by various methods, analyzing the gas at regular intervals, or determining

Some Typical Carburizing Applications

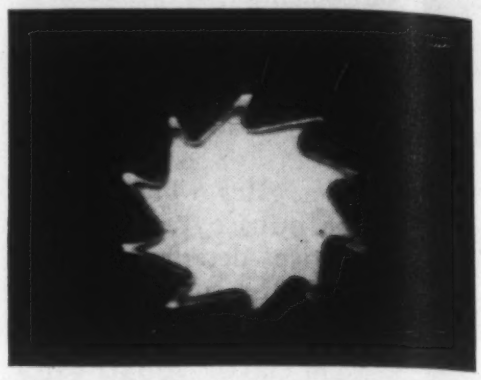
Part Adjusting cone for Jones & Lamson turret lathe spring collet
Steel Carpenter Super Sampson 5 chromium, 0.10% carbon
Prior Treatment Stress relieved at 1200 F
Carburizing Furnace
Type Gas
Atmosphere Cracked liquid
Temp 1750 F
Time 12 hr
Subsequent Heat Treatment Air-cooled after carburizing, tempered at 300 F
Remarks L & N furnace with carbon control set at 0.57% carbon used in carburizing

(Courtesy Jones and Lamson, and Leeds & Northrup)



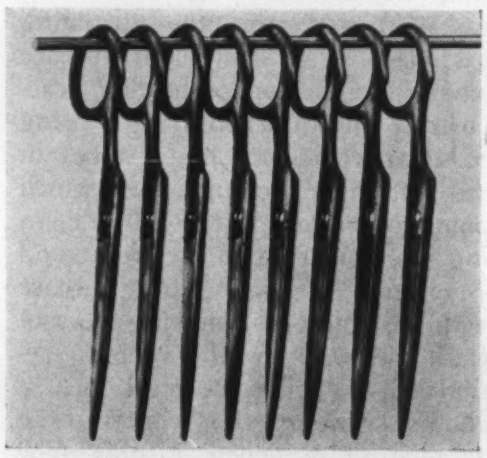
Part Cam or worm gear
Steel SAE 8620
Case Depth 0.040 to 0.060 in. (min hardenable)
Carburizing Furnace
Type Gas, pit furnace
Atmosphere Enriched cracked gas
Temp 1700 F
Time 7 to 9 hr, depending on size of cam
Subsequent Heat Treatment Furnace cooled to 1575 F, held ½ hr, oil-quenched, washed, tempered at 325 F for 1 hr.
Remarks Copper-plated on one end to prevent carburizing so cam can be welded after treatment. Total time, 11½ to 14 hr.

(Courtesy Surface Combustion Corp.)



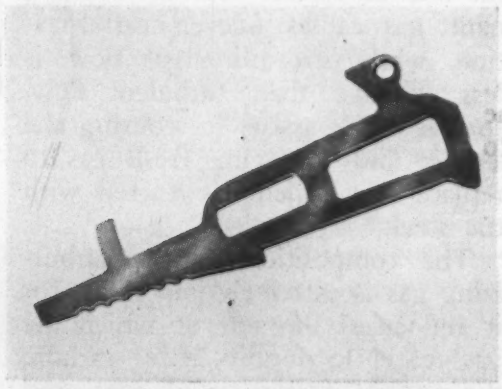
Part Typewriter type-action drive shaft
Steel SAE 1020
Case Depth 0.015 in.
Carburizing Furnace
Type Gas
Atmosphere Cracked liquid
Temp 1650 F
Subsequent Heat Treatment Oil-quenched into rapidly agitated oil at 110 F, degreased, reheated to 1475 F, quenched, tempered 1 hr at 350 F
Remarks Shafts are 0.489-in. dia by 12½ in. long and are held vertically in a special fixture for carburizing and heat treatment

(Courtesy Underwood Corp.)



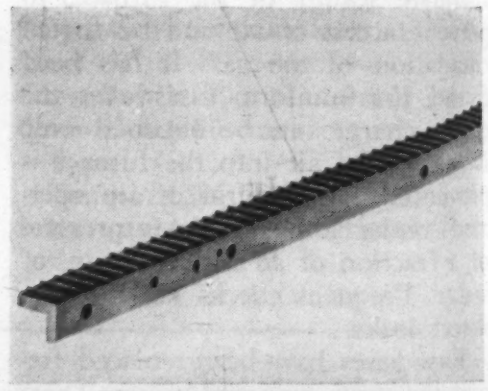
Part Shear and scissor blades
Steel SAE 1020
Case Depth 0.020 in. min
Carburizing Furnace
Type Salt bath
Medium Water soluble salts
Temp 1600 F
Subsequent Heat Treatment Quenched in oil at 125 F, hot water rinsed, tempered 20 min in salt bath at 600 F
Remarks Blades are immersed to a point just above the shoulders

(Courtesy Clayton Manufacturing Co. and American Cyanamid Co.)



Part Electric typewriter escapement pawl
Steel AISI 1035
Case Depth 0.006 to 0.008 in.
Carburizing Furnace
Type Salt bath
Medium Water soluble salts
Temp 1550 F
Time ½ hr
Subsequent Heat Treatment Oil quenched and tempered to a hardness of Rockwell C52 to 55

(Courtesy International Business Machines Corp. and American Cyanamid Co.)



Part Electric typewriter escapement rack
Steel AISI 4615
Case Depth 0.015 to 0.017 in.
Carburizing Furnace
Type Salt bath
Medium Water soluble salts
Temp 1650 F
Time 1 hr
Subsequent Heat Treatment Air cooled, hot water rinsed, teeth only hardened by high frequency induction heating followed by water quenching, teeth tempered to a Rockwell hardness of A80 to 82

(Courtesy International Business Machines Corp. and American Cyanamid Co.)

the dew point of the gas. The test piece method is the only satisfactory procedure for pack carburizing but it is also used frequently in gas carburizing. Some organizations do not release the work for further processing until the test pieces have been inspected and certified as satisfactory.

It has been stated that, in gas carburizing, the dew point method is more sensitive than gas analysis and permits determination of changes in furnace conditions more rapidly. It is necessary, however, to prepare graphs relating the dew point to the carbon monoxide-carbon dioxide ratio for the atmosphere being used in the furnace. A recently developed instrument employs a system analogous to temperature control for controlling the carburizing gas. In this method a steel wire is carburized by the gas in the furnace, and it is said that the exact control of the carburizing potential of the atmosphere is obtained. This wire is inserted directly in the furnace and is suitable only for use with a specific atmosphere.

A similar procedure is about to be commercialized which operates in a slightly different manner. In this case a sample of gas is drawn continuously from the furnace and passed over a steel wire placed outside the furnace. It is stated that this unit can be used with any carburizing atmosphere on both batch and continuous furnaces. Methods of analyzing the gas continuously have also been employed for determining the atmosphere although they have been used only to indicate the composition and not to control it.

In the operation of a gas carburizing furnace, certain safety precautions are necessary, for the gas is both toxic and explosive. Adequate ventilation of the working area around the furnace is necessary. The explosion hazard can be minimized by admitting gas to the furnace after the temperature is above the ignition temperature of the gaseous mixture. The air-gas mixture then burns quietly and the products of combustion can be purged before the charge is placed in the furnace. Since air can seep into the furnace vestibules during charging and discharging, small explosions can occur in these areas. However, the explosive hazard is minimized frequently by burning gas in the vestibules. In one type of furnace a "hat" is installed over the vestibule. When an explosion occurs, this hat blows upward along a guided track and releases the pressure. It then falls back into position. In other types, the doors are hinged and blow outward when explosions occur. Under development is a unit for use with any gas atmosphere furnace which will burn the gases in small quantities when air leaks into the furnace and thus reduce the explosion hazhard. The hazards mentioned apply particularly to continuous furnaces. Batch furnaces, because of their manner of operation, are considered to be less hazardous by some authorities.

Since most of the equipment is quite expensive, gas carburizing is especially suited to volume work. Many furnaces are of the continuous pusher type, and the charge is loaded on trays which are pushed forward automatically at the desired rate. Furnaces of this type will handle up to 2 tons of parts per hr. However, for handling materials at lower rates of production of the order of 300 to 500 lb per hr, for example, batch furnaces are used. In some of these furnaces, the atmosphere is produced by decomposing a suitable fluid hydrocarbon in the furnace, thus considerably reducing the equipment cost by eliminating the requirement of a gas cracking and mixing unit. In another type, a catalytic cracking unit is installed within the furnace to eliminate the external cracking unit. In some pit-type carburizing furnaces, propane is used without a carrier gas. This makes an economical installation since neither an amtosphere generator nor a fluid hydrocarbon pump is required.

The advantages of gas carburizing include positive control of case depth, adaptability to large volume production and to the carburization of small parts, adaptability to batch or continuous furnaces, and low labor costs in comparison to the pack method. Disadvantages include the requirement of technical personnel to supervise the operation, atmosphere control required at regular intervals, soot formation must be controlled, and greater space requirements than salt baths.

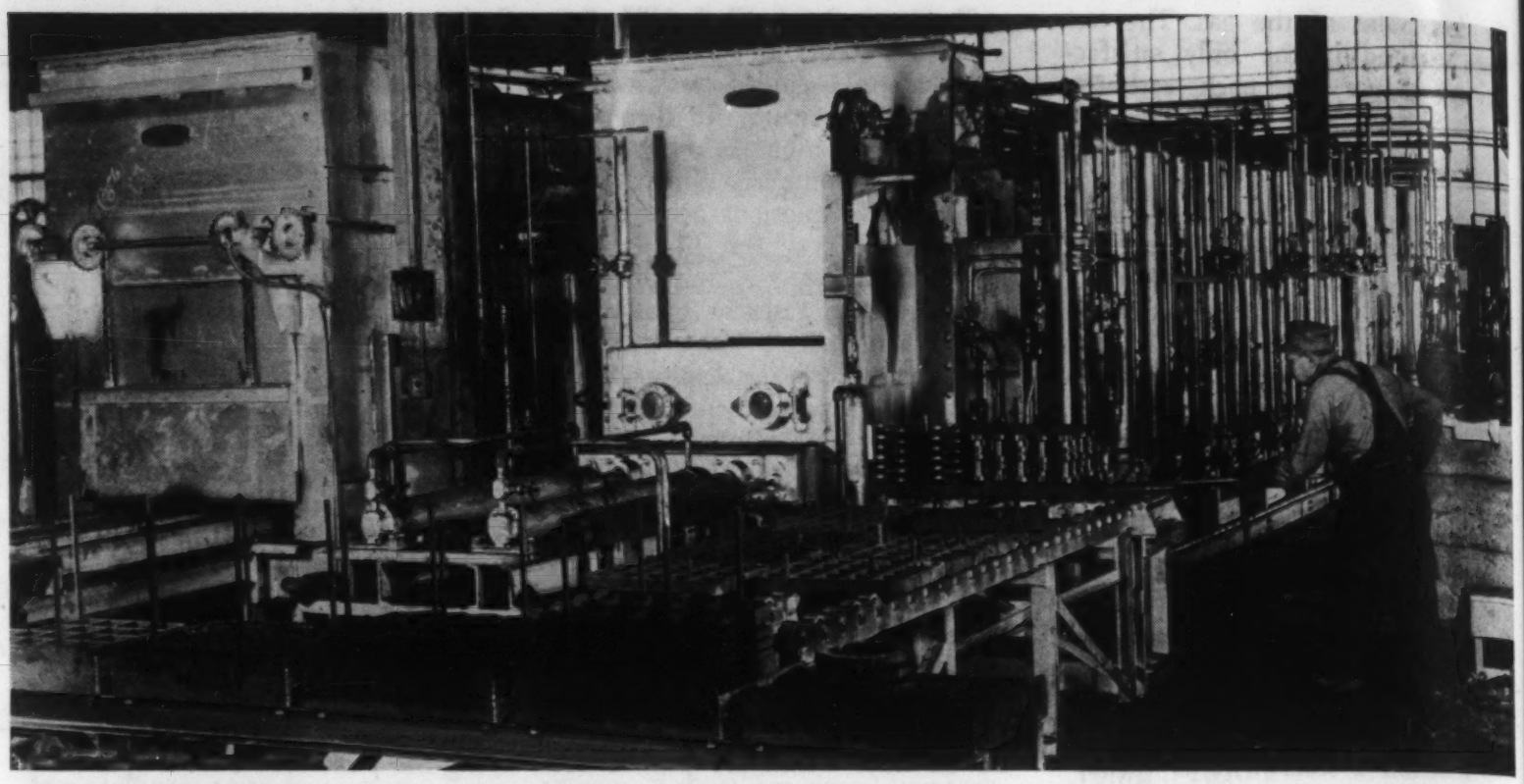
Liquid Carburizing

The third method of case hardening steels with carbon is liquid carburizing. This method is replacing the pack method for specialized operations particularly.

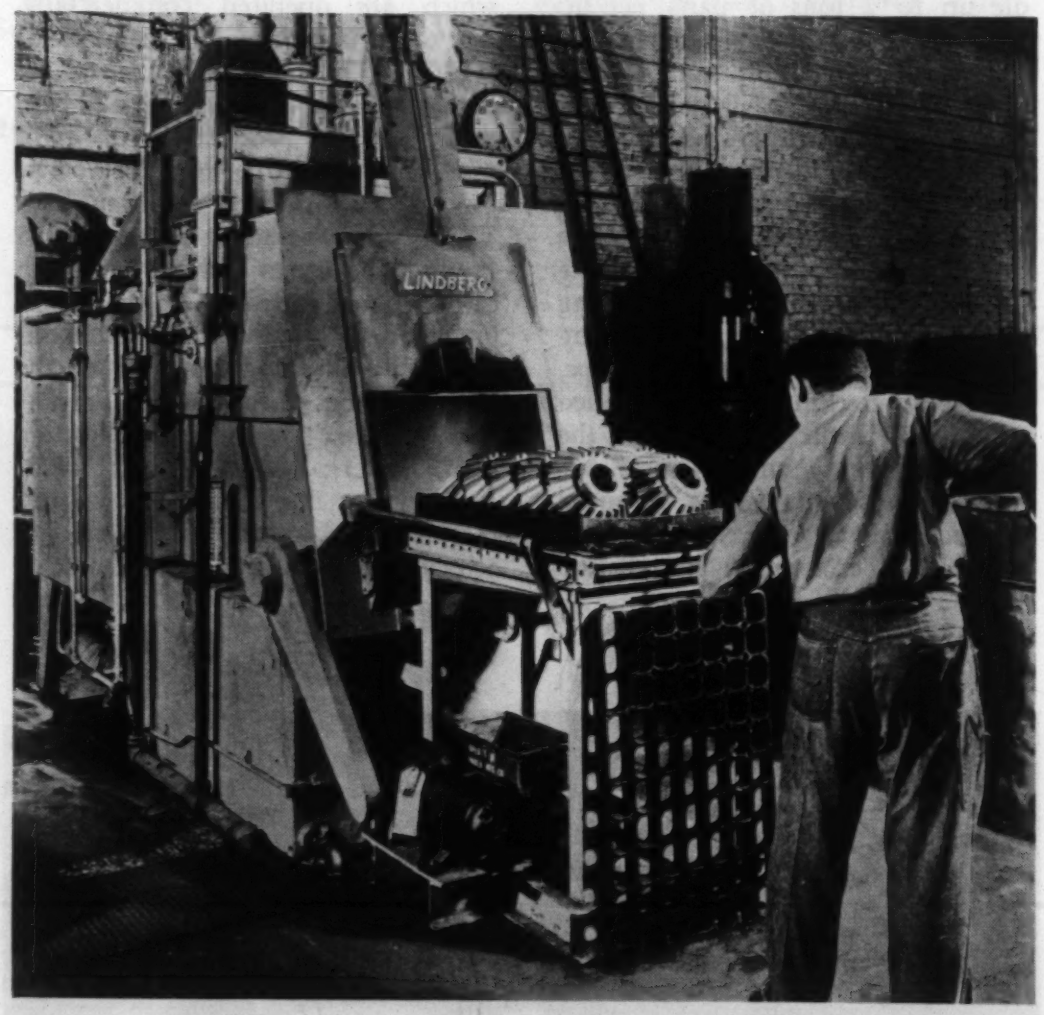
In all liquid case hardening baths which are operated commercially, the carburizing medium consists of cyanides. The original bath was sodium cyanide, and this bath is still used for the production of light cases up to 0.010 in. deep. The process is known as cyaniding. These baths operate at 1350 to 1625 F, and the cases consist of both carbides and nitrides. At the lower temperature, nitrides are predominant while at the upper end of the range carbides form the major portion of the case. A plain cyanide bath, however, should not be confused with a liquid carburizing bath.

The liquid carburizing baths are activated or catalyzed. For cases of

Battery of Surface Combustion pit-type gas carburizing furnaces installed by the Caterpillar Tractor Co. for treating five sizes of track link bushings. The bushings, made from a steel chemically similar to SAE 1018, are given a 0.079- to 0.995-in. case by heating for 23 hr at 1560 F.



Fully mechanized gas carburizing and heat treating unit for the mass production of automotive gears. (Holcroft & Co.)



Charging a batch of gears into a Lindberg vertical radiant tube gas carburizing furnace.

moderate depth up to 0.040 in. they usually contain barium compounds, although if water soluble materials are desired for ease of removal from the surface acidic oxides, phosphates or fluorides can be used. Cases produced in activated baths contain a smaller percentage of nitrogen than those produced in cyanide baths, are less brittle, and more nearly resemble those obtained in pack and gas carburizing.

A modified bath in which the neutral salt contains no carburizing salt is also in use commercially. The active agent is added from the time to time and the carbon penetration is controllable to some extent. This bath is said to be the most economical to operate, but has the disadvantage that it contains calcium chloride. On removal of the work, drag-out of the salts leaves a residue which is hygroscopic and must be removed by washing thoroughly to prevent rusting of the work.

For heavy cases, all liquid baths contain barium catalysts. These baths have low cyanide contents averaging from 8 to 12% and operate at the higher end of the temperature range from 1700 to 1750 F, with a few installations operating at 1800 F. The bath is always covered with powered carbon or graphite to conserve heat and protect it from excessive contact with the atmosphere. This procedure is usually employed for cases in the range 0.030 to 0.100 in., although deeper cases can be produced.

There is some disagreement on the manner in which carburizing proceeds in the liquid bath. In any event, it appears that the basic reaction of the plain cyanide bath, the oxidation of a cyanide to a cyanate by air or possibly by carbon dioxide, followed by the decomposition of the cyanate to yield active nitrogen and active carbon, also occurs in the liquid carburizing bath. A summarized version of the manner in which the reactions occur is:

$$2NaCN + O_2 \rightleftarrows NaCNO$$

$$4NaCNO \rightleftarrows Na_2CO_3 + 2NaCN + CO + 2N_{[active]}$$

$$Fe + 2CO \rightleftarrows C_{[active]} + CO_2$$
$$Ca_2 + NaCN \rightleftarrows NaCNO + CO$$
$$2NaCN + BaCl_2 \rightleftarrows Ba(CN)_2 + 2NaCl$$

In the major reaction, known as the "cyanamide shift," the barium cyanide formed as indicated above, assists in supplying carbon to the steel by decomposing in the following manner:

$$Ba(CN)_2 \rightleftarrows BaCN_2 + C_{[active]}$$

In these reactions the carbon enters the steel and no sooting occurs. The case formed in such a bath resembles that obtained in pack or gas carburizing more closely than the cases produced in plain cyanide baths.

Because of the intimate contact between the liquid bath and the workpiece, the temperature of the latter is raised rapidly by conduction to the carburizing temperature. Liquid carburizing baths also operate generally at higher temperatures than are used in gas carburizing procedures and, therefore case formation and diffusion are more rapid. The combination of these two factors increases the speed of obtaining equivalent case depth materially. For example, a 0.040-in. case can be formed on AISI 1020 steel in 2 hr in a salt bath, while considerably more time is required in other processes because of the lower rate of heating to the carburizing temperature. However, when the material reaches the carburizing temperature, carburizing proceeds at the same rate in all three processes.

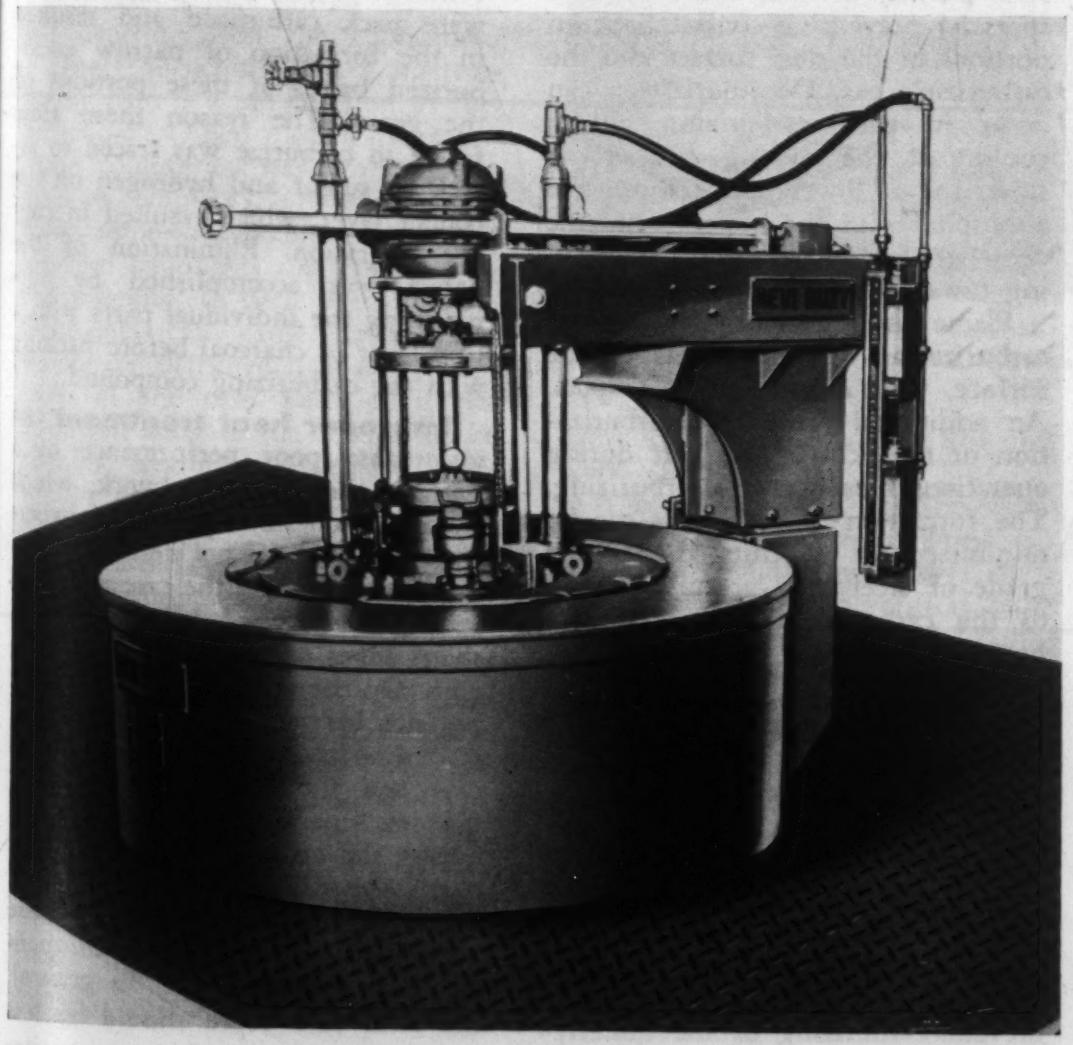
Liquid carburizing is claimed to have the advantage of producing uniform cases regardless of the density of loading of the work. Other authorities disagree, stating that too great a load leads to non-uniform cases. The process is highly flexible. Different depths of case can be obtained in the same furnace by varying the carburizing cycle. Similarly, a piece can be carburized selectively by immersing only the section to be case hardened, and no stopoff is necessary. Parts carburized in liquid baths are free from scaling and decarburization, and there is no soot problem. No particular problem is involved if certain areas of parts which must be fully immersed are not to be carburized. Competent authorities state that these areas should be copper plated to prevent carburization.

Sometimes liquid carburizing can be combined with other operations advantageously. Since parts can be readily transferred to subsequent operations using the same fixtures, special heat treatments, such as martempering, often follow carburizing. The cycle can be made fully automatic, if desired. In addition, brazing with brazing alloys selected to have similar melting ranges can be accomplished while the part is carburized.

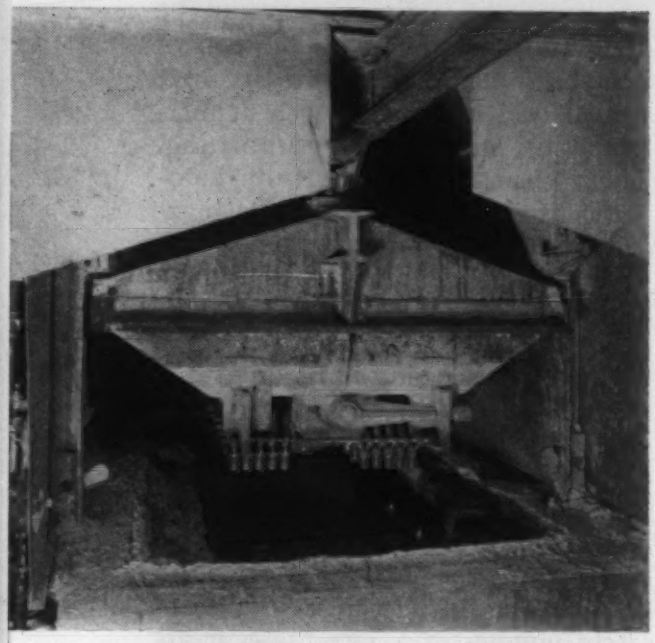
Liquid carburizing has several disadvantages. As in the handling of all liquids maintained at high temperatures, care must be taken to prevent the entry of wet parts to the bath to prevent the formation of steam and the expulsion of the liquid. The operator should wear safety goggles or a face mask at all times while handling the furnaces. It is well known that cyanides are poisons. However, it is not so well known that the fumes which may occur above a cyanide bath are not cyanides, for at the high temperatures they are immediately oxidized to carbonates upon exposure to air. Although the fumes are not toxic, they are uncomfortable to the operators and adequate ventilation should be provided. Clean housekeeping is necessary in handling and storing the solid material. The salts must not be allowed to come into contact with acids or hydrocyanic acid will be formed, a gas which is very toxic. However, if these facts are recognized and suitable precautions are taken, satisfactory results can be obtained with a minimum of hazard, as has been demonstrated by the many cyanide salt baths in operation today.

Liquid carburizing baths can be heated externally by gas or oil firing or by electrical resistance methods. They can also be heated internally by immersed electrodes or other methods. Although all of these methods have been employed, external fuel firing of a metal pot or immersed electrodes in either a metal or ceramic pot are the most popular procedures.

Externally fired salt baths have certain disadvantages. Since the container walls also serve to conduct the heat to the bath, a metallic container is necessary. The temperature on the firing side must be several hundred degrees above that of the bath and, therefore, the maximum operating temperature is limited if economical pot life is to be obtained. These requirements have limited the size of externally-fired carburizing baths.



Vertical retort furnace for positive pressure gas carburizing using either a gas or a cracked liquid atmosphere. (Hevi-Duty Electric Co.)



Carburizing shafts in an immersed electrode salt bath. The fixture holds the shafts vertically and at the proper depth. (Dempsey Industrial Furnace Co.)

The internally heated salt bath does not have these disadvantages. In the immersed electrode type, the heat is supplied by the resistance of the salt to the passage of an alternating current. The container serves only to hold the salt and can be constructed of ceramic materials or metal, although metallic containers are generally used. Sizes and shapes can be varied greatly. Since the temperature of the container is no higher than that of the bath, it has been possible to increase the operating temperature somewhat, and this type of bath now operates generally at an average temperature of 1750 F for carburizing. This high operating temperature has the economic advantage of reducing the carburizing time to 50% of that required in a bath operating at 1650 F. Because of the increased flexibility in this type of unit, carburizing salt baths are now in operation ranging in size from small batch type pots of limited output to extensive fully mechanized units for mass production.

Many of the advantages and disadvantages of liquid carburizing baths have been mentioned. Among other advantages are reduction of space requirements over pack carburizing, freedom from sooting and oxidation problems, and low distortion of parts. Disadvantages include the facts that parts must be washed thoroughly after treatment to prevent rusting, regular adjustment of the bath composition is necessary to obtain uniform case depths, and some shapes cannot be handled in this equipment because they will float or cause excessive drag-out of the salt.

Carburizing Defects: Their Causes and Prevention

Variation in the depth of case in pack carburizing can result from improper packing. In a box improperly packed, free flow of gas to all parts of the surface can be prevented, certain portions of the surface will be in contact with gas for insufficient time to be carburized fully, and thin sections will occur. Case depth variation throughout a charge can result also from variations in the temperature in different parts of the furnace chamber in both pack and gas carburizing. These variations can be reduced by improved operating practice.

The production of a suitable case is a function of time and temperature. Cases too thin to function satisfactorily can result from attempts to rush the process. On the other hand, heavy cases, unless properly graduated from surface to core, are inclined to be brittle and may fail in service. During the formation of heavy cases, care must be taken to prevent through-carburizing of thin sections, which can result in the formation of excessively brittle areas in these locations.

Soft spots can result from steel quality or abnormality, phosphorus segregation, unevenness of carburization, and flame impingement on the part. According to some authorities, a completely abnormal steel can be completely hardened only in very small parts which are given a drastic quench, for during quenching the carbon in these steels has a tendency to precipitate and constituents softer than martensite are formed.

In pack carburizing, the use of compound which contains an excessive quantity of fines can cause soft spots by preventing contact between portions of the steel surface and the carburizing gas. Decarburization can occur in pack carburizing during cooling if the cooling rate is too slow, for at lower temperatures the atmospheres in the box can become decarburizing rather than carburizing toward the steel.

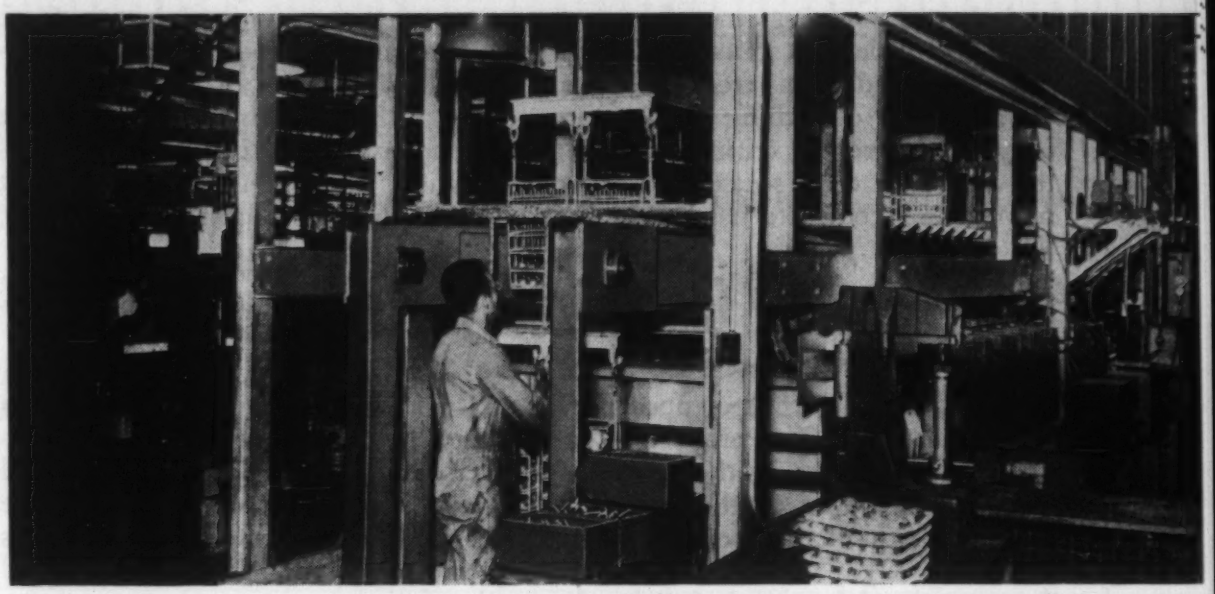
Flame impingement, causing decarburization of small areas of the surface, will also cause soft spots. An additional cause is decarburization of the skin of the part during operations subsequent to carburizing. The formation of soft spots can be minimized by selecting the proper grade of steel and careful attention to the carburizing and subsequent heat treating cycles.

Sooting in gas carburizing can interfere with carburizing in addition to spoiling the appearance of the work. Suggested methods for overcoming sooting have been discussed previously.

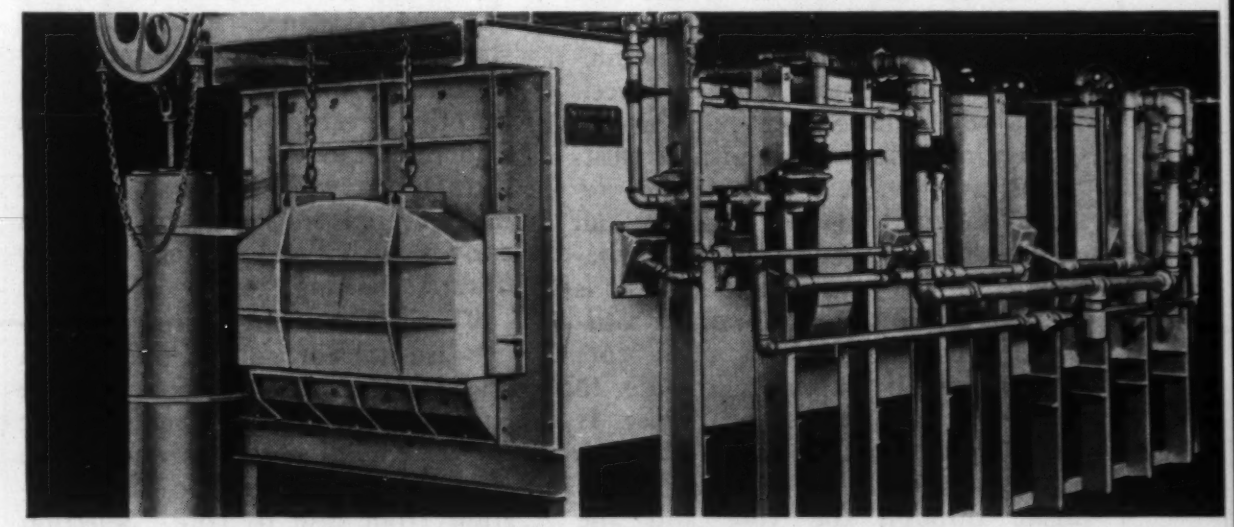
Stop-off defects have been reported on parts having areas protected by copper plating. The more common is failure of the plate to prevent carburizing of the underlying area, caused generally by a copper-plate which is too thin to offer complete protection from penetration by the gas. A second type is failure to form a case in areas adjacent to the copper stop-off. This type of failure has been reported to occur on small bevel gears which were pack carburized and resulted in the formation of narrow uncarburized bands at these portions of the gears. The reason these areas failed to carburize was traced to attack by sulfur and hydrogen on the copper layer, which resulted in copper migration. Elimination of the defect was accomplished by surrounding the individual parts with a thin layer of charcoal before packing with the carburizing compound.

Improper heat treatment can also cause poor performance of a part. If the carbide network, which is formed on slow cooling of hypereutectoid steels, is not destroyed during heat treatment, the case will have a tendency toward brittleness, and sharp edges on the part will tend to chip. On the other hand, if the core has not been heat treated properly, it can be too weak to support the case and the latter may crack. If thin sections are through-carburized during the carburizing cycle and the part is quenched in water or brine, hardening cracks can occur. The remedy is the prevention of through-carburizing of the part. In general, the total case depth should be less than the thickness of the core after carburizing.

Heat Treatment after Carburizing



Refrigerator parts being loaded into a mechanized liquid carburizing unit. The parts are carried through the carburizing bath at 1750 F, a cleaning bath at 1450 F, a water quench, a tempering bath at 150 F, washed, rinsed and returned by conveyor to the loading station. (Ajax Electric Co.)



Oven-type furnaces, gas or oil fired, can be used for pack or gas carburizing. (Sunbeam Corp.)

After completion of the carburizing cycle, the steel has a duplex structure consisting of a high carbon case and a low carbon core. Since the addition of carbon to iron lowers the critical range, the case can be hardened at a lower temperature than the core. Thus, steel containing 0.10 to 0.20% carbon requires quenching from 1560 to 1600 F, while steel containing from 0.9 to about 1.1% carbon need be heated only to 1400 to 1430 F. Because of these differences, a considerable range of case and core properties is possible by using a combination of heat treatments.

Direct quenching from the carburizing furnace into oil is being employed more extensively each year because it is the least expensive procedure and distortion is reduced when a single quench is used. Both case and core are hardened by this procedure, but there is no grain refinement in either. Thus, fine-grained steels should be used to obtain the best combination of properties. This procedure favors the retention of austenite in the case, which may or may not be detrimental, depending on the application.

Direct quenching into a martempering bath is a modification of this procedure. Other modifications include cooling to sub-zero temperatures to complete the transformation. Some authorities do not approve of sub-zero treatments for transforming the austenite. In their opinion, such treatments can cause hard spots, which are detrimental to the properties of the case. Each additional operation adds to the cost, and the simplest treatment which will develop the required properties is generally employed.

It is sometimes desirable to cool the material slowly in order that machining operations can be performed before hardening. The critical cooling speed of the steel must not be exceeded if the softest condition is to be obtained. This introduces an additional factor in steels having hypereutectoid cases, for slow cooling favors the precipitation of the carbides in a network pattern which makes the case quite weak. Unless double heat treatments are to be employed, slow cooling should be limited to steels containing no more than the eutectoid concentration of carbon in order to prevent the formation of this network structure.

A modification of this procedure intended to minimize retained austenite is cooling by blower to a temperature below the critical range of the steel. The rate of cooling must be high enough to prevent the formation of a network structure in the case. After such treatment the parts can be slowly cooled to room temperature or reheated to about 1450 F and quenched.

Following slow-cooling, there are several widely used procedures for heat treatment. Briefly, they are:

1. Reheat just above the critical temperature of the case and quench, the quenching medium being selected to suit the particular steel. Since this temperature is below the critical range of the core, it does not harden and no grain refinement occurs. This procedure is most applicable to fine-grained steels. The method has the advantage of retaining the core in a condition suitable for machining while distortion is minimized because of the low temperature quench. If the carbon content of the case is held to the eutectoid composition, a hard wear resistant case results. On the other hand, if carbon above the eutectoid composition is present, and the steel is cooled slowly, the carbide network will not be dissolved by this treatment and the case will tend to be weak and brittle.

2. A modification of this treatment requires that the quenching temperature be raised to a value in-

termediate between those required for case and core, for example 1470 to 1490 F. With this treatment partial hardening of the core occurs and there is some grain refinement. Excess carbide can cause a brittle, weak case under this treatment also.

3. If the quenching temperature is raised above the critical range of the core, the core structure will be refined and complete hardening can be obtained upon quenching in a suitable medium. Excess carbide in the case will usually be redissolved, although there may be some coarsening of the grain in the case. Since there is only one quenching treatment, distortion can be minimized.

4. If quenching from the core hardening range is followed by reheating and quenching from just above the critical range of the case, the best combination of toughness and ductility obtainable in a case-hardened steel is developed. This is desirable for coarse-grained steels.

Following any of these treatments, the steels should be reheated to 275 to 350 F for the relief of strains. If such temperatures are selected on the basis of steel composition, no reduction in the hardness of the case occurs.

Properties of Carburized Parts

A carburized part is composed of duplex material. The properties desired, therefore, are neither those of the case nor those of the core, but the best combination of the two. Since the high carbon content of the case tends toward brittleness, the core must be strong enough to support the case, without undue flexure, in order to minimize cracking tendencies.

Another requirement of the core is toughness. Although toughness is frequently determined on pseudo-carburized specimens, that is, specimens which have been put through the entire carburizing and heat treatment cycle without carburizing, results obtained in this fashion can be misleading. Toughness as measured by the usual tension test is not necessarily a criterion of satisfactory core properties. The core requires notch toughness in order to resist the propagation of cracks. If notch toughness is not achieved, cracks starting in the case will propagate through the core and the entire piece will fail in a brittle fashion. If suitable resistance to crack propagation is attained in the core, a crack starting in the case will be stopped at the junction between case and core.

In a case-hardened steel, the surface is in compression, a condition very favorable for resistance to reversed stresses. Thus, the carburized steels normally show good resistance to bending fatigue. However, it is becoming more generally accepted that fatigue resistance is not a major requirement in many carburized parts. In gears, for example, it is considered that fatigue failure is rather rare and the principal requirement of a carburized part is abrasion resistance. Case hardened steels usually have superior wear resistance to directly hardened steels, but the structure of the case is an important factor. A fine case structure is best while a coarse structure has lowered resistance to abrasion and also has a greater tendency toward cracking.

The ordinary engineering properties are not particularly useful as a criterion for the selection of case hardened parts. More important are surface condition and hardness, type of metallurgical structure, and gradation from case to core. Selection is based to a very large extent on experience with actual parts under service conditions and a study of parts which have functioned satisfactorily or failed in service. Thus, in one aircraft organization, it has been found that carburized parts fail in service if the surface hardness is Rockwell C-59 and operate satisfactorily if the hardness is C-60. No explanation for this sharp demarkation line has been found, and it is doubtful whether its existance could have been predicted from laboratory tests. For reasons such as this, selection is generally based on service or simulated service tests.

Applications

There are so many applications of carburized steels that a mere listing would serve no useful purpose. Therefore, case histories of a number of carburized parts have been included on pages 142 and 144 to give the engineer some idea of the manner in which the carburizing processes have been used and suggest to him suitable applications.

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Buick Motors Div., General Motors Corp.
Caterpillar Tractor Co.
Clayton Manufacturing Co.
Dempsey Industrial Furnace Corp.
Denfis Chemical Co.
Doughty Laboratories, Inc.
Dow Furnace Co.
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Comparative Specifications for Alloy Steels

Specifications have been revised to Apr. 1, 1952, but specifications are subject to constant revision and the sponsoring organization should be consulted for the latest revision.

U. S. MILITARY SPECIFICATIONS

Specification	W.D. or Type	C	Mn	P (Max)	S (Max)	Si	Ni	Cr	Mo	V	Form	Nearest Corr. Number SAE	AISI	AMS
6866 (Ships) Amend 1 supersedes 46-S-32b	B	.12- .19	.37- .63	.045	.045	.18- .37	1.05-1.45	.52- .78	—	—	Bars	3115	3115	—
	C	.12- .19	.42- .68	.045	.045	.18- .37	1.60-2.05	—	.17- .33	—	Bars	4615	4615	6290C
6871 (Ships) Amend 1 supersedes 47-S-23a	—	.20 max	.50- .90	.040	.040	.15- .30	.050 max	—	.40- .65	—	Plate	—	—	—
6980 supersedes O.S.801 Rev. D	—	.95-1.10	.25- .45	.025	.025	.20- .35	.35 max	1.30-1.60	.08 max	—	Bars	—	—	—
43182 supersedes 46-S-50 (Ships)	—	.10- .20	.40- .70	.040	.040	.15- .35	1.65-2.00	—	.20- .30	—	Forgings & bars	4615	4615	6290C
5000A Amend 1 supersedes MIL-S-5000	4340	.38- .43	.65- .85	.040	.040	.20- .35	1.65-2.00	.70- .90	.20- .30	—	Bars	4340	4340	6415D
5626 Amend 1 supersedes AN-QQ-S-752	4140	.37- .43	.70-1.05	.040	.040	.20- .35	—	.80-1.15	.15- .25	—	Bars & rods	4140	4140	6382D
5694 supersedes 46-S-25	6135	.30- .40	.50- .80	.040	.045	.20- .35	—	.80-1.10	—	.15- .25	Bars	—	—	—
6049 Amend 1 supersedes AN-S-16a	8740	.37- .43	.70-1.05	.040	.040	.20- .35	.35- .75	.35- .65	.20- .30	—	Bars & rods	8740	8740	6322D, 6324A, 6325C, 6327C
6050 Amend 1 supersedes AN-S-14a	8630	.27- .33	.60- .95	.040	.040	.20- .35	.35- .75	.35- .65	.15- .25	—	Bars & rods	8630	8630	6280C
6098 Amend 1 supersedes AN-S-15a	8735	.33- .38	.70-1.05	.040	.040	.20- .35	.35- .75	.35- .65	.20- .30	—	Bars & rods	8735	8735	6320D
6709 supersedes AN-S-19a	†A	.38- .43	.50- .70	.040	.040	.20- .40	—	1.40-1.80	.30- .40	—	Bars & rods	—	—	— 6360C
	‡B	.30- .40	.50-1.10	.040	.040	.20- .40	—	1.00-1.50	.15- .25	—	Bars & rods	—	—	— 6361, 6362
6731 supersedes AN-T-3a	4130	.26- .33	.40- .60	.040	.040	.20- .35	—	.80-1.10	.15- .25	—	Tubing	4130	4130	6371C
6732 Amend 1 supersedes AN-T-15	8630	.27- .33	.70- .90	.040	.040	.20- .35	.40- .70	.40- .60	.15- .25	—	Tubing	8630	8630	6530C, 6281B, 6550C
6733 Amend 1 supersedes AN-T-22a	8735	.33- .38	.75-1.00	.040	.040	.20- .35	.40- .70	.40- .60	.20- .30	—	Tubing	8735	8735	6282C
6734 Amend 1 supersedes AN-T-33a	8630	.27- .33	.70- .90	.040	.040	.20- .35	.40- .70	.40- .60	.15- .25	—	Tubing	8630	8630	6530C, 6281B, 6550C
6735 Amend 1 supersedes AN-T-68	4135	.32- .39	.40- .70	.040	.040	.20- .35	—	.80-1.10	.15- .25	—	Tubing	4137	E4135	6372C, 6381
6736 Amend 1 supersedes AN-T-69	4130	.27- .33	.40- .60	.040	.040	.20- .35	—	.80-1.10	.15- .25	—	Tubing	4130	4130	6360C, 6361
6758 Amend 1 supersedes AN-S-684	4130	.27- .34	.35- .65	.040	.040	.20- .35	.25 max	.80-1.15	.15- .25	—	Bars & rods	4130	4130	6370D, 6362, 6371C
10439 (Ord.) supersedes 57-121 (1 part)	4130	.26- .34	.30- .60	.040	.040	.15- .30	—	.80-1.15	.15- .25	—	Plate	4130	4130	6350B
	4140	.36- .45	.70-1.00	.040	.040	.15- .30	—	.80-1.15	.15- .25	—	Plate	4140	4140	—
	8620	.16- .23	.60- .90	.040	.040	.15- .30	.40- .70	.40- .65	.15- .25	—	Plate	8620	8620	—
	8630	.26- .34	.60- .90	.040	.040	.15- .30	.40- .70	.40- .65	.15- .25	—	Plate	8630	8630	6355D
	8640	.36- .45	.70-1.00	.040	.040	.15- .30	.40- .70	.40- .65	.15- .25	—	Plate	8640	8640	—
	8720	.16- .23	.60- .90	.040	.040	.15- .30	.40- .70	.40- .65	.20- .30	—	Plate	8720	8720	—
	8730	.26- .34	.70-1.00	.040	.040	.15- .30	.40- .70	.40- .65	.20- .30	—	Plate	—	—	—
	8740	.36- .45	.70-1.00	.040	.040	.15- .30	.40- .70	.40- .65	.20- .30	—	Plate	8740	8740	6358A
	9440	.36- .45	.90-1.25	.040	.040	.15- .30	.30- .60	.30- .55	.08- .15	—	Plate	9440	9440	—
	9445	.41- .45	1.00-1.35	.040	.040	.15- .30	.30- .60	.30- .55	.08- .15	—	Plate	9445	9445	—
15073 (Bu.Ord.) Amend 1	4	.35- .45	.35- .60	.040	.040	.20- .35	2.75-3.25	1.30-1.80	—	—	Forgings & bars	—	—	—
supersedes O.S.477 Rev. G	5	.79- .90	.50- .80	.030	.030	.15- .30	.25 max	1.00-1.40	—	—	Forgings & bars	—	—	—

† contains .90-1.35 Al. ‡ Also contains .85-1.20 Al, .15-.35 Se.

(Continued on Page 155)

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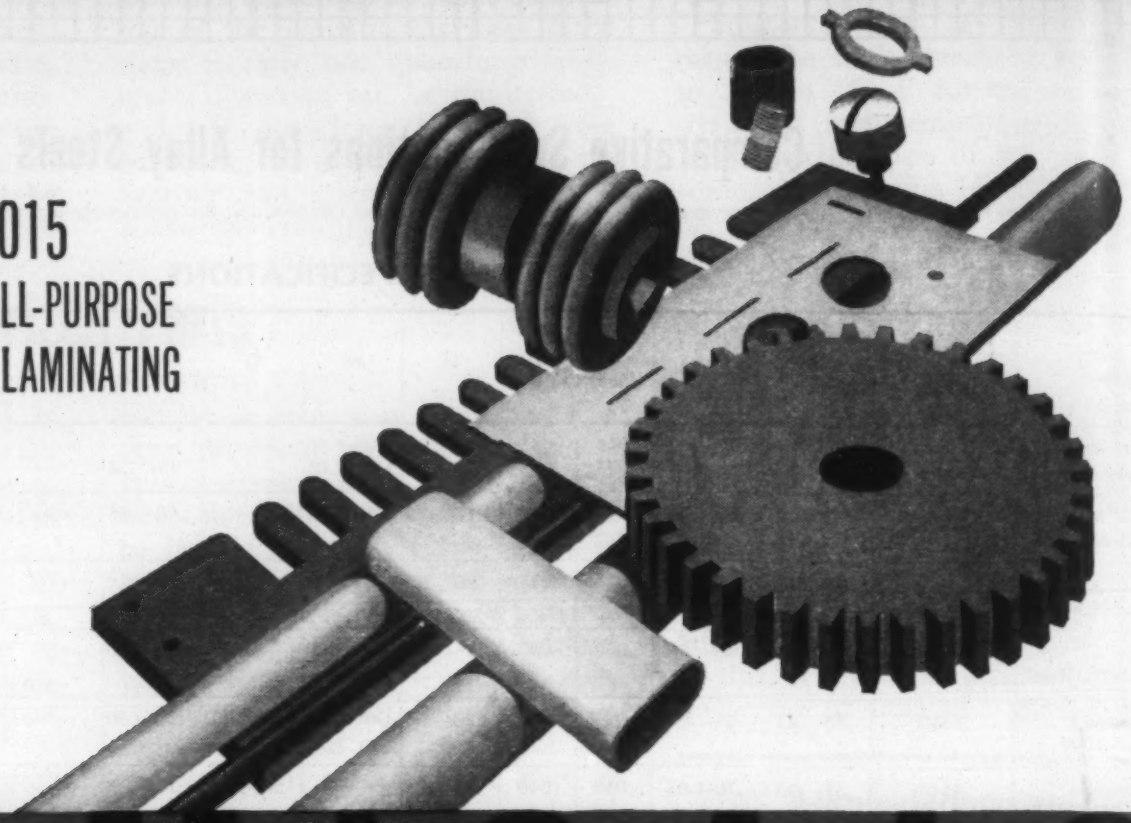

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U. S. ARMY SPECIFICATIONS

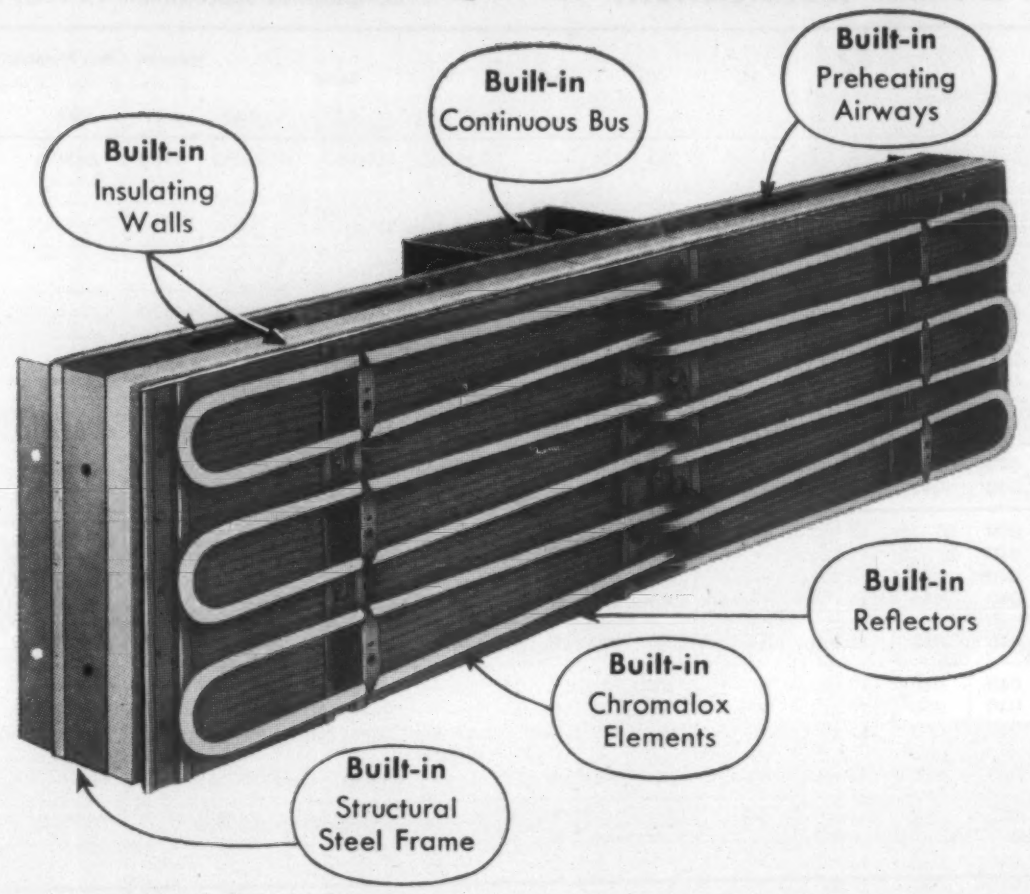
Comparative Specifications for Alloy Steels

Specification	W.D. or Type	C	Mn	P (Max)	S (Max)	Si	Ni	Cr	Mo	V	Form	Nearest Corr. Number SAE	AISI	AMS
48-7A	6150	.45- .55	.60- .90	.040	.050	.15- .30	——	.80-1.10	——	.15 min .18 des	Wire	6150	6150	6450B
48-7-1 Amend I	6150 Spec.	.45- .50	.25- .50	.025	.025	.15 min	——	.80-1.10	——	.15 min	Wire	——	——	——
57-103-1 Amend I	3415	.10- .20	.30- .60	.040	.050	.15 min	2.75-3.25	.60- .90	——	——	Bars	——	——	——
	4120A	.15- .25	.70-1.00	.040	.050	.15 min	——	.40- .70	.15- .30	——	Bars	——	——	——
	4320	.15- .25	.40- .70	.040	.050	.15 min	1.65-2.00	.30- .60	.20- .30	——	Bars	4320	4320	——
	4815	.10- .20	.40- .60	.040	.050	.15 min	3.25-3.75	——	.20- .30	——	Bars	4815	4815	——
	4820	.15- .25	.40- .60	.040	.050	.15 min	3.25-3.75	——	.20- .30	——	Bars	4820	4820	——
	5120	.15- .25	.60- .90	.040	.050	.15 min	——	.60- .90	——	——	Bars	5120	5120	——
57-107-18A	2512	.08- .14	.30- .60	.040	.050	——	4.75-5.25	——	——	——	Bars & rods	2512	2512	6240C
57-107-22A	1	.08- .12	.30- .60	.040	.050	——	3.25-4.00	1.25-1.75	——	——	Bars & rods	3310	E3310	6250D
	2	.14- .19	.30- .60	.040	.050	——	3.25-4.00	1.25-1.75	——	——	Bars & rods	3316	E3316	——
57-107-25a Amend III	4140 Spec.	.35- .45	.70-1.00	.040	.05-.10	.15 min	——	.80-1.10	.15- .25	——	Bars	——	——	——
	4150 Spec.	.45- .60	.60- .90	.040	.05-.10	.15 min	——	.80-1.10	.15- .25	——	Bars	——	——	——
	4150 Mod.	.45- .60	.60- .90	.040	.050	.15 min	——	.80-1.10	.15- .25	——	Bars	——	——	——
	Cr-Mo-Va	.40- .50	.40- .70	.040	.040	.15- .30	.35 max	.80-1.10	.30- .40	.20- .30	Bars	——	——	——
57-107-34	X4340	.35- .45	.60- .90	.040	.050	.15 min	1.65-2.00	.60- .90	.20- .30	——	Bars	4340	4340	6415D
57-136B Amend VII	4130	.25- .35	.40- .60	.040	.050	.15 min	——	.80-1.10	.15- .25	——	Sheet, strip	4130	4130	6350B
	X4135	.30- .40	.40- .60	.040	.050	.15 min	——	.80-1.10	.15- .25	——	Sheet, strip	4137	E4135	6352B
	6150	.45- .55	.60- .90	.040	.050	.15 min	——	.80-1.10	——	.15 min .18 des	Sheet, strip	6150	6150	6455B
	8635	.30- .40	.70-1.00	.040	.050	.15 min	.40- .70	.40- .60	.15- .25	——	Sheet, strip	8635	8635	——
57-136-8C Amend III	X4130	.25- .35	.40- .60	.040	.045	——	——	.80-1.10	.15- .25	——	Sheet, strip	4130	4130	6350B
57-180D Amend IV	2330	.25- .35	.50- .80	.040	.050	15 min	3.25-3.75	——	——	——	Tubing	2330	2330	——
	2340	.35- .45	.60- .90	.040	.050	.15 min	3.25-3.75	——	——	——	Tubing	2340	2340	——
	4030	.25- .35	.60- .90	.040	.050	15 min	——	——	.20- .30	——	Tubing	4032	4032	——
	4035	.30- .40	.70-1.00	.040	.050	.15 min	——	——	.20- .30	——	Tubing	4037	4037	——
	4050	.45- .55	.70-1.00	.040	.050	.15 min	——	——	.20- .30	——	Tubing	4053	4053	——
	4060	.55- .70	.70-1.00	.040	.050	.15 min	——	——	.20- .30	——	Tubing	4063	4063	——
	X4130	.25- .35	.40- .60	.040	.050	.15 min	——	.80-1.10	.15- .25	——	Tubing	4130	4130	
	X4135	.30- .40	.40- .60	.040	.050	.15 min	——	.80-1.10	.15- .25	——	Tubing	4137	E4135	
	4140	.35- .45	.70-1.00	.040	.050	.15 min	——	.80-1.10	.15- .25	——	Tubing	4140	4140	——
	4615	.10- .20	.40- .70	.040	.050	.15 min	1.65-2.00	——	.20- .30	——	Tubing	4615	4615	——
	6150	.45- .65	.60- .90	.040	.050	.15 min	——	.80-1.10	——	.15 min .18 des	Tubing	6150	6150	——
	8630	.25- .35	.70-1.00	.040	.050	.15 min	.40- .70	.40- .60	.15- .25	——	Tubing	8630	8630	
	8635	.30- .40	.70-1.00	.040	.050	.15 min	.40- .70	.40- .60	.15- .25	——	Tubing	8635	8635	——
	8740	.35- .45	.70-1.00	.040	.050	.15 min	.40- .70	.40- .60	.20- .30	——	Tubing	8740	8740	6323B
	8750	.45- .55	.70-1.00	.040	.050	.15 min	.40- .70	.40- .60	.20- .30	——	Tubing	8750	8750	——
	8950	.45- .55	1.00-1.30	.040	.050	.15 min	.40- .70	.40- .60	.30- .40	——	Tubing	——	——	——
AXS—160	6150 Spec.	.45- .55	.25- .50	.025	.025	.15 min	——	.80-1.10	——	.15 min	Strip	——	——	——
AXS—907 Amend I	2330	.25- .35	.50- .80	.040	.050	.15 min	3.25-3.75	——	——	——	Bars	2330	2330	——
	2340	.35- .45	.60- .90	.040	.050	.15 min	3.25-3.75	——	——	——	Bars	2340	2340	——
	3135	.30- .40	.50- .80	.040	.050	.15 min	1.00-1.50	.45- .75	——	——	Bars	3135	3135	6330A
	3140	.35- .45	.60- .90	.040	.050	.15 min	1.00-1.50	.45- .75	——	——	Bars	3140	3140	——
	3240	.35- .45	.30- .60	.040	.050	.15 min	1.50-2.00	.90-1.25	——	——	Bars	——	——	——
	3250	.45- .55	.30- .60	.040	.050	.15 min	1.50-2.00	.90-1.25	——	——	Bars	——	——	——
	4020	.15- .25	.60- .90	.040	.050	.15 min	——	——	.20- .30	——	Bars	4023	4023	——
	4040	.35- .45	.70-1.00	.040	.050	.15 min	——	——	.20- .30	——	Bars	4042	4042	——
	4045	.40- .50	.70-1.00	.040	.050	.15 min	——	——	.20- .30	——	Bars	4047	4047	——
	4050	.45- .55	.70-1.00	.040	.050	.15 min	——	——	.20- .30	——	Bars	4053	4053	——
	X4130	.25- .35	.40- .60	.040	.050	.15 min	——	.80-1.10	.13- .20	——	Bars	4130	4130	6370D
	4140	.35- .45	.70-1.00	.040	.050	.15 min	——	.80-1.10	.13- .20	——	Bars	4140	4140	6382D
	4150	.45- .55	.70-1.00	.040	.050	.15 min	——	.80-1.10	.13- .20	——	Bars	4150	4150	——
	X4340	.35- .45	.60- .90	.040	.050	.15 min	1.65-2.00	.60- .90	.20- .30	——	Bars	4340	4340	6415D
	4640	.35- .45	.50- .80	.040	.050	.15 min	1.65-2.00	——	.20- .30	——	Bars	4640	4640	6312A
	6150	.45- .55	.60- .90	.040	.050	.15 min	——	.80-1.10	——	.15 min .18 des	Bars	6150	6150	6448B
	8620	.15- .25	.70-1.00	.040	.050	.15 min	.40- .60	.40- .70	.15- .25	——	Bars	8620	8620	6274F
	8640	.35- .45	.70-1.00	.040	.050	.15 min	.40- .70	.40- .60	.15- .25	——	Bars	8640	8640	——
	8645	.40- .50	.70-1.00	.040	.050	.15 min	.40- .70	.40- .60	.15- .25	——	Bars	8645	8645	——
	8650	.45- .55	.70-1.00	.040	.050	.15 min	.40- .70	.40- .60	.15- .25	——	Bars	8650	8650	——
	9420	.15- .25	.80-1.10	.040	.050	.40- .60	.20- .50	.20- .40	.08- .15	——	Bars	——	——	——
	9430	.25- .35	.90-1.20	.040	.050	.40- .60	.20- .50	.20- .40	.08- .15	——	Bars	——	——	——
	9440	.35- .45	.90-1.20	.040	.050	.40- .60	.20- .50	.20- .40	.08- .15	——	Bars	9440	9440	——
	9445	.40- .50	1.00-1.30	.040	.050	.40- .60	.20- .50	.20- .40	.08- .15	——	Bars	9445	9445	——
	9450	.45- .55	1.20-1.50	.040	.050	.40- .60	.20- .50	.20- .40	.08- .15	——	Bars	——	——	——
	9540	.35- .45	1.20-1.50	.040	.050	.40- .60	.40- .70	.40- .60	.15- .25	——	Bars	——	——	——
	9545	.40- .50	1.20-1.50	.040	.050	.40- .60	.40- .70	.40- .60	.15- .25	——	Bars	——	——	——

Nearest Corr. Number AMS
6360C 6361 6362 6371
6381 6372
6530C 6550C 6281B

(Continued on Page 157)

Announcing a **new** and **better** *INFRARED* **Generator**



CHROMALOX *Electric* RADIANT PANELS

Now, more efficient *far*-infrared comes in convenient pre-engineered panels, reducing oven building to a matter of determining heat requirements and assembling panels to fit the job.

CHROMALOX Electric Radiant Panels generate more uniformly absorbed *far*-infrared heat with quick heat-up and reduced oven lengths.

It's the *far*-infrared wave length that makes the difference.

- ✓ **9200 Btu's per square foot output per hour.**
- ✓ **Insulated for voltages to 575 V.**
- ✓ **Lowest installed cost per kilowatt and per square foot.**
- ✓ **Work temperatures to 700° F. easily obtained.**
- ✓ **Accurate "dialed" control.**
- ✓ **Absolutely uniform radiation—no hot or cold spots.**
- ✓ **Built to UL and NBFU requirements.**

Now. . . Oven Building as Simple as A B C

It's easy to build ovens of any desired height and length with lightweight Chromalox Electric Radiant Panels. Panels come in 1 x 4 ft. and 2 x 4 ft. sizes, ready to erect and connect with easy-to-follow instructions in each carton. Chromalox on-the-spot engineering assistance to help determine your requirements is yours—no obligation, of course.

CHROMALOX *Electric Heat*

Does More - Better - Consistently

Radiant Heating Division EDWIN L. WIEGAND CO.,
7523 THOMAS BLVD., PITTSBURGH 8, PA.

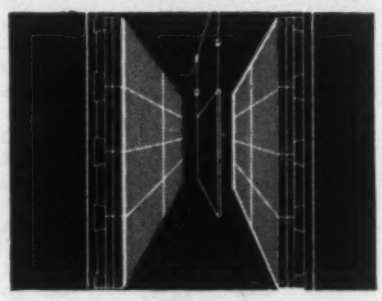
CHROMALOX FAR-INFRARED

For Baking, Drying, Curing, Dehydrating

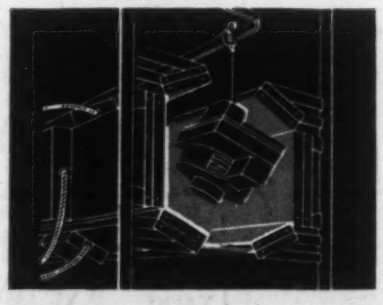
and many other applications.

9 WAYS BETTER

1. **Longer wave length**—absorbed equally fast by all colors.
2. **Shatter-proof construction**—nothing to break and contaminate.
3. **Non-diminishing output** from all-metal Chromalox tubular heat generators.
4. **Uniform heat**—no hot or cold spots.
5. **High intensity radiation**—with more watts per square foot.
6. **Quick heat-up** with energy transformed instantly into heat on the work.
7. **Low-cost oven assembly.**
8. **Infinitely variable output**—from 0 to 100% of capacity.
9. **Additionally safe** for any work involving volatiles.



Easily erected banks of Chromalox Radiant Panels are ideal for line production. *Far*-infrared heat is radiated directly and uniformly without hot spots over entire work area.



Chromalox Radiant Panels can be erected into any oven shape. Rugged construction permits their use in assembly lines, even when hazards of splashed liquids, volatiles and moisture are present.

Get this Bulletin

It contains complete information, specifications and application ideas for the use of Chromalox Radiant Panels. Write for your copy today.

IC-66

Materials Engineering File Facts

MATERIALS & METHODS
October • 1952
Number 237

U. S. NAVY SPECIFICATIONS

Comparative Specifications for Alloy Steels

Specification	W.D. or Type	C	Mn	P (Max)	S (Max)	Si	Ni	Cr	Mo	V	Form	Nearest Corr. Number SAE	AISI	AMS
4733 Amend 1	—	.20 max	.80 max	.040	.040	.10- .50	—	—	.40- .55	—	Tubing	—	—	—
4746 (Ord.)	—	.36- .45	.72-1.04	.045	.045	.18- .37	.37- .73	.37- .63	.14- .27	—	Tubing	8740	8740	6323B
4364 (Int.)	2330	.25- .35	.50- .80	.040	.045	.15- .35	2.75-3.75	—	—	—	Bars	2330	2330	—
	2340	.35- .45	.60- .90	.040	.045	.15- .35	2.75-3.75	—	—	—	Bars	2340	2340	—
	W	.30- .45	.45- .75	.040	.040	.15- .35	2.75-3.75	.60- .95	—	—	Bars	—	—	—
	X	.45- .55	.45- .75	.030	.040	.15- .35	2.75-3.75	.60- .95	—	—	Bars	—	—	—
4325	6135	.30- .40	.50- .80	.040	.045	.15- .35	—	.80-1.10	—	.15- .25	Bars	6150	6150	6448B
4331	I	.45- .50	.60- .80	.025	.025	—	—	.80-1.10	—	.15- .35	Bars	6150	6150	6448B
	II	.45- .50	.70- .90	.040	.040	3.00-3.50	—	.25- .35	—	.18 min	Bars	—	—	—
4332b	b	.12- .19	.37- .63	.045	.045	.18- .37	1.05-1.45	.52- .78	—	—	Bars	3115	3115	—
	c	.12- .19	.42- .68	.045	.045	.18- .37	1.60-2.05	—	.17- .33	—	Bars	4615	4615	6290C
4339b	A	.45 max	1.00 max	.050	.050	.15- .35	2.25 min	1.25 max	.45 min	.12 max	Forgings	4340	4340	6415D
	B	.40 max	1.00 max	.045	.045	.15- .35	2.50 max	.85-1.25	.50-1.50	.20- .30	Forgings	4340	4340	6415D
4350 (Int.)	—	.10- .20	.40- .70	.040	.040	.15- .35	1.65-2.00	—	.20- .30	—	Forgings & bars	4615	4615	6290C
4353 (Int.)	4	.45- .55	.62- .93	.045	.050	.15- .35	—	.75-1.15	—	.15 min	Bars & wire	6150	6150	6448B
	5	.50- .65	.60- .91	.045	.050	1.75-2.25	—	—	—	—	Bars & wire	9260	9260	—
4361 (Ord.)	—	.35- .45	.70-1.00	.040	.040	.20- .35	.40- .70	.40- .60	.15- .30	—	Bars	8640	8640	—
4523a	—	.20 max	.50- .90	.040	.040	.15- .35	.050 max	.40- .65	—	—	Plate	—	—	—
4356d	—	.30 max	.70 max	.040	.045	—	3.00 min	—	—	—	Plate	2317	2317	—

U. S. ARMY-NAVY AERONAUTICAL SPECIFICATIONS

Specification															
AN-T-3a	4130	.26- .33	.40- .60	.040	.040	.20- .35	—	.80-1.10	.15- .25	—	Tubing	4130	4130		6360C, 6361, 6362, 6371C
AN-S-9a Amend 1	4037	.35- .40	.75-1.00	.040	.040	.20- .35	—	—	.20- .30	—	Bars & rods	4037	4037	6300	
AN-S-12 Amend III	8630	.27- .33	.70- .90	.040	.040	.20- .35	.40- .70	.40- .60	.15- .25	—	Sheet, strip	8630	8630	6355D	
AN-S-13b	8620	.18- .23	.75-1.00	.040	.040	.20- .35	.40- .70	.40- .70	.15- .25	—	Bars & rods	8620	8620	6274F	
AN-S-14a Amend 1	8630	.27- .33	.70- .90	.040	.040	.20- .35	.40- .70	.40- .60	.15- .25	—	Bars & rods	8630	8630	6280C	
AN-S-15a Amend 1	8735	.33- .38	.75-1.00	.040	.040	.20- .35	.40- .70	.40- .60	.20- .30	—	Bars & rods	8735	8735	6320D	6530C, 6281B
AN-T-15a	8630	.27- .33	.70- .90	.040	.040	.20- .35	.40- .70	.40- .60	.15- .35	—	Tubing	8630	8630		6550C
AN-S-16a Amend 1	8740	.38- .43	.75-1.00	.040	.040	.20- .35	.40- .70	.40- .60	.20- .30	—	Bars & rods	8740	8740		6322D, 6324A
AN-S-22 Amend II	8735	.33- .38	.75-1.00	.040	.040	.20- .35	.40- .70	.40- .60	.20- .30	—	Sheet, strip	8735	8735	6357C	6325C, 6327C
AN-T-22a	8735	.33- .38	.75-1.00	.040	.040	.20- .35	.40- .70	.40- .60	.20- .30	—	Tubing	8735	8735	6282C	
AN-T-33a	8630	.27- .33	.70- .90	.040	.040	.20- .35	.40- .70	.40- .60	.15- .25	—	Tubing	8630	8630		6530C, 6550C
AN-S-57	6150	.48- .53	.70- .90	.040	.040	.20- .35	—	.80-1.10	—	.15 min	Sheet, strip	6150	6150	6455B	6281B
AN-S-58	6150	.48- .55	.65- .90	.040	.040	.20- .35	—	.80-1.10	—	.15 min	Rod & wire	6150	6150	6450B	
AN-T-68	4135	.32- .39	.40- .70	.040	.040	.20- .35	—	.80-1.10	.15- .25	—	Tubing	4137	E4135		6372C, 6381
AN-T-69	4130	.27- .33	.40- .60	.040	.040	.20- .35	—	.80-1.10	.15- .25	—	Tubing	4130	4130		6360C, 6361, 6362, 6371C
AN-S-684	4130	.27- .34	.35- .65	.040	.040	.20- .35	.25 max	.80-1.15	.15- .25	—	Bars & rods	4130	4130	6370D	
AN-QQ-S-685 Amend V	4130	.27- .33	.40- .60	.040	.040	—	—	.80-1.10	.15- .25	—	Plate, sheet & strip	4130	4130	6350B	
AN-QQ-S-686 Amend II	4135	.30- .40	.40- .70	.040	.050	—	—	.80-1.10	.15- .25	—	Plate, sheet & strip	4137	E4135	—	
AN-QQ-S-687 Amend III	6150	.45- .55	.60- .90	.040	.050	—	—	.80-1.10	—	.15 min	Bars	6150	6150	6448B	
AN-QQ-S-688a Amend I	6195	.90-1.05	.20- .45	.030	.035	—	—	.80-1.10	—	.15 min, .18 des	Bars & Rods	—	—	—	
AN-QQ-S-689a Amend I	2330	.28- .33	.60- .90	.040	.040	—	3.25-3.75	—	—	—	Bars & rods	2330	2330	—	
AN-QQ-S-690 Amend II	3140	.35- .45	.60- .90	.040	.050	—	1.00-1.50	.45- .75	—	—	Bars & rods	3140	3140	—	
AN-QQ-S-752a Amend I	4140	.35- .42	.60- .90	.040	.050	—	—	.80-1.10	.15- .25	—	Bars & rods	4140	4140	6382D	
AN-QQ-S-756a Amend III	X4340	.35- .45	.60- .80	.040	.050	—	1.65-2.00	.60- .90	.20- .30	—	Bars & rods	4340	4340	6415D	

FEDERAL SPECIFICATIONS

QQ-W-474a supersedes QQ-W-474	D	.48- .55	.65- .90	.040	.040	.20- .35	—	.80-1.10	—	.15 min, .18 des	Wire	6150	6150	6450B	
QQ-S-624 Amend I	General purpose specification covering most all grades from 2317 to 9850 inclusive													

30% weight reduction

in heat-treat tray cuts operating costs

Weighing approximately 20 pounds less than the previous assembly, this Thermalloy heat-treat tray means the user spends less money "heating the pot" and gets more "cooking" in a working day.

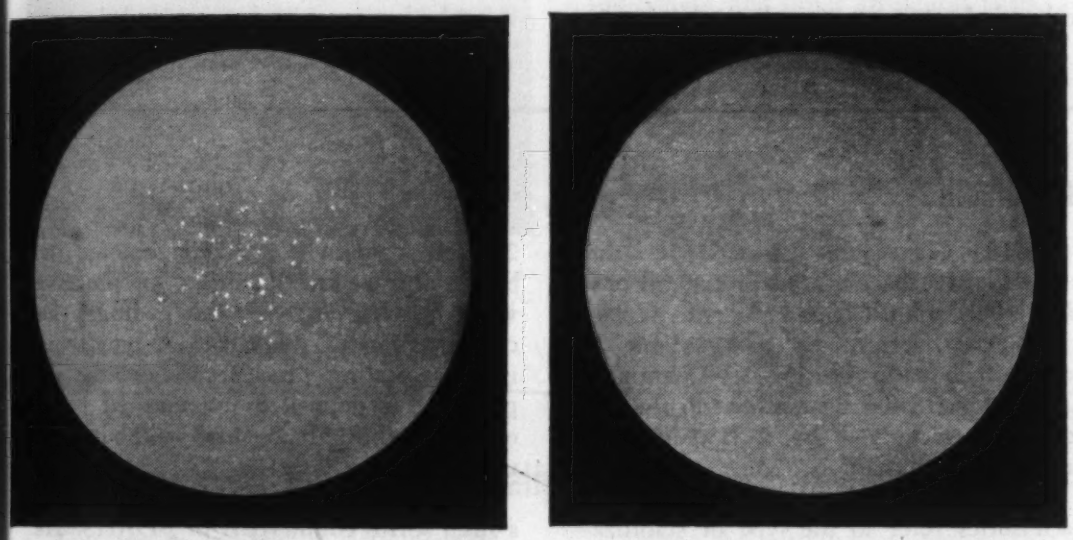
Designed in Thermalloy with the help of Electro-Alloys engineers, this assembly is suited to ideal foundry practice as well as to customer service requirements. One major customer advantage is flexibility of use . . . loadings can vary from very small diameter washers and nuts up to larger requirements measuring 7½″ in diameter.

Thermalloy is not just one alloy, but a group of alloys . . . each specially adapted to certain heat and abrasion requirements. Let an Electro-Alloys engineer show you how you can cut operating costs with parts correctly engineered in the right grade of Thermalloy. Call your nearest Electro-Alloys sales office, or write Electro-Alloys Division, 2082 Taylor Street, Elyria, Ohio. *Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

New Materials and Equipment



Polished and etched disks of high alloy tool steel: left, from standard bar; right, from Desegatized bar.

Segregation-Free High Alloy Tool Steels Produced in Large Sizes

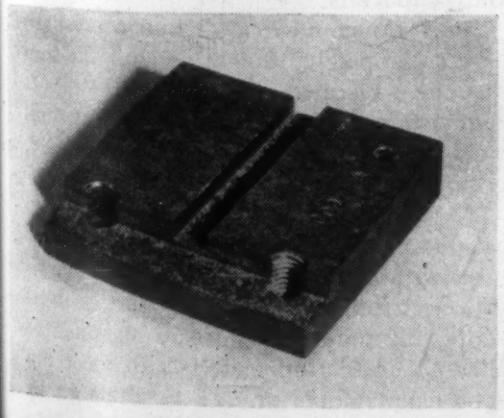
Six years ago *Latrobe Steel Co.*, Latrobe, Pa., announced the development of a series of high-speed steels that were free of carbide segregation. This development has now been extended by Latrobe to the large commercial sizes of high-speed and high - carbon - high - chromium bars. They can now successfully produce bars of Desegatized tool steel up to 10 in. in dia, and higher if required.

By eliminating the concentration or clustering of free carbides at the center of the bar stock, a number of advantages are gained. One of these is better hot forming properties. Carbide segregation at the center of high alloy tool steels can lead to heavy scrap losses during hot forming due to internal ruptures. Excessive segregation also results in so-called "hard spots," which impair the machinability properties. Since in Desegatized steels there are no such carbide concentrates, the problem is considerably alleviated.

Another advantage of these tool steels is their uniform response to heat treatment. Because of the uniform distribution of carbides, the common difficulties encountered in heat treating—brittleness in spots, warpage and distortion, and breakage due to locked-up stresses—are all minimized. Finally, extra toughness is achieved in bars having no carbide clusters.

Size has no influence upon the quality of Desegatized high alloy tool steels because there is no carbide segregation present to begin with. Therefore, the same quality remains from the largest to smallest sizes. However, when conventional bars are hot worked down into smaller bar and rod sizes, the carbide segregations elongate or string out and their harmful effects remain.

Fibrous Insulating Sheet Materials Readily Fabricated



This heavy gage fibrous insulating sheet can be drilled, tapped, machined or sawed.

Heavy gage fibrous insulating sheet materials comparable in physical strength to fabric-base laminates and stronger than paper-base laminates have been announced by *Rogers Corp.*, Manchester, Conn. The new thicknesses, which go up to 3 in., are now available in two grades, Duroid 700 and Duroid 800.

Both materials can be readily drilled, tapped, machined or sawed, using conventional type equipment. The edge finish can be classified as excellent.

In their lighter gages (0.031 to 0.125 in.), Duroid 700 is used for formed electrical insulating parts and 800 for flat insulating parts requiring a low rate of water absorption. In many instances, Duroid 800 has replaced paper-base laminated phenolic, for the sole support of current carrying parts.

In the new heavy gages, the materials are said to have improved water absorption characteristics, which, in turn, provide improved dimensional stability and contribute greatly to surface flatness. The rate of absorption for a 24-hr period of immersion is less than 5% for the 2-in. gage of Duroid 800 and less than 10% for the 2-in. gage of 700. Like other Duroids, the materials can be fungus proofed or surface treated to meet special requirements.

New Materials and Equipment continued

Jet Black Finish for Iron and Steel Has High Corrosion Resistance

Parts treated with the new black finish.

A new jet black finish for iron and steel, said to have ten times the corrosion resistance of conventional blacks, has been developed by *Parker Rust Proof Co.*, Detroit 11, and is available under the trade name Parco Black.

The new product is used in water solution at low temperatures. Parts to be treated are immersed for 15 to 30 min. in the processing bath, then are rinsed and dried. After oiling or waxing, the deep black, durable finish is ready for service.

Advantages claimed for the finish are: the processing bath is non-caustic, extremely simple to build and easy to control; operating temperatures are much lower than those required for other widely used black processes; any part which can be immersed in the tank can be treated; and the process is entirely suitable for machined or threaded parts.

Rubber Latices Tailored for Specific Requirements

The introduction of four new synthetic rubber latices, each tailored to meet specific requirements, has been announced by the Chemical Div., *Goodyear Tire & Rubber Co.*, Akron 16. The new additions to the company's line of Chemigum Latices were described as aqueous dispersions of butadiene—acrylonitrile copolymers designed particularly for use in coating, impregnating and compounding applications requiring unusual adhesion or resistance to oils, greases, alcohols, glycols and most solvents.

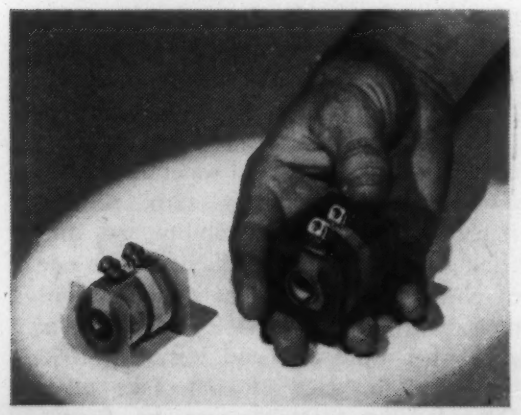
In the 235 series, Chemigum Latex 235AHS, Chemigum Latex 235C and 235CHS have been added to expand possible applications. The 235 series is said to be characterized by a butadiene to acrylonitrile ratio of 55/45. Chemigum Latex 245AHS has been added to the 245 series, characterized by a butadiene to acrylonitrile ratio of 67/33.

The alphabetical designations within each series refer to the type of stabilization. In the 235 series, Chemigum Latex 235AHS is a high solids modification of the popular 235A and is stabilized with an ammonia soap. Latex 235C and 235CHS contain a synthetic anionic stabilizer to insure stability in processes which tend to increase the hydrogen ion concentration of the latex. A typical use is in saturating processes where the impregnant is deposited by repeated passes of a web through the bath without coagulation of the latex.

Within the 245 series, 245A now has a high solids counterpart in 245AHS. The high solids latices give a much greater solids pick up in some of the processes and are also more economical to ship and store.

Epoxy Resins for Encapsulating Electrical Components

Two new epoxy type insulating resins for complete encapsulation of electrical components where moisture resistance, high dielectric strength and a tough protective coating are required have been announced by *Minnesota Mining and Manufacturing Co.*, 900 Fauquier St., St. Paul. Designated Scotchcast electrical insulating resins No. 1 and No. 2, the new materials are expected to find wide use in the manufacture of coils, transformers and other electrical components designed for critical applications.



New epoxy resins are used for encapsulating these electrical components.

The resins are currently being used for embedding resistors, unitized electronic circuits, pre-amps, torroids, and both audio and power transformers—hermetically scaled—in a solid block of resin to give trouble-free operation under adverse conditions. In addition, they are being used for dip impregnation on coils where increased resistance to moisture is desired instead of the conventional varnish-impregnated paper and cloth insulation.

Resin No. 1 comes in a solid form, together with a catalyst and is heated until liquefied for pouring into the mold. The resin then sets and is cured at 250 F in from 4 to 8 hr. Scotchcast electrical insulating resin No. 2 comes in a liquid form together with a hardener and can be poured into the mold and cured at room temperature in from 3 to 6 hr.

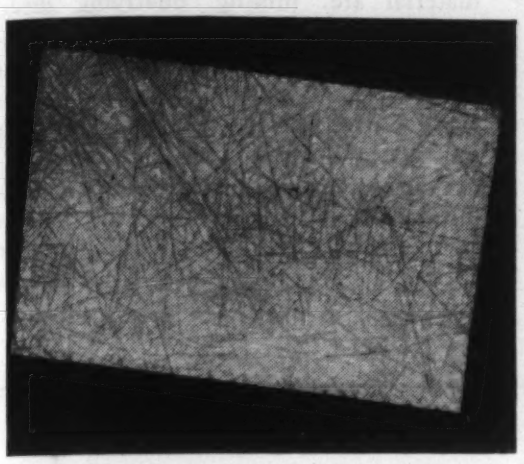
Either type resin can be used for most applications, depending largely on available production facilities. In the case of electronic components unable to withstand high temperatures, the No. 2 cold-pouring type may be required.

Outstanding features claimed for the new resins are their 100% solids nature with no volatile products and a minimum of shrinkage upon curing; no chemical degradation within the operating range from —40 F to 250 F; resistance to acids, alkalies, solvents and oils, and excellent adhesion to most metals, plastics and conductors.

Both resins have a dielectric strength of approximately 1000 v per mil on thin sections. Neither material will support combustion, both are inert to fungus, and both can be machined, drilled, tapped, ground or turned.

A wide variety of filler materials such as aluminum oxide, mica or glass can be used with the resins for improving physical, electrical or chemical properties. Basically, the unfilled resins are classified as Class A insulating materials to meet hot spot temperatures of 221 F, although by the addition of suitable fillers they can be processed to meet Class B requirements.

Laminated Plastics Sheet with Good Strength and Electrical Properties



Good strength and electrical properties are offered by this laminated plastics sheet.

A new grade of laminated thermosetting sheet material has been introduced by the *Continental-Diamond Fibre Co.*, Newark, Del. Called Dilecto GM-1, it is a fiberglas mat, melamine resin bonded product with high arc and flame resistance qualities. Lower in cost than currently available woven glass fabric base melamine laminates, GM-1 is suitable for many applications: switchboard panels, sub-panels, and other structural parts, arc barriers for switches and circuit breakers, as well as television flyback transformer panels, armature and field coil slot wedges and spacers.

The new material has high tensile, flexural and impact strengths. It is said to be moisture resistant and to possess good electrical properties, particularly arc resistance. Heat resistance is rated at 300 F continuous, 350 F intermittent.

Tests conducted on this grade according to ASTM test methods show the following range of properties:

Flexural Strength, Psi	21,000-28,000
Impact Strength, Ft-Lb per In. of Notch Edgewise	5.5-6.5
Dielectric Strength, K. V. Step by Step, Parallel with Laminations	45.-50.
Arc Resistance, Sec	160-185
Water Absorption, 24 hr, %, 1/8-In. Thick Specimen	1.5-2.0
Density	1.75-1.80

Production at present calls for 38- by 38-in. and 38- by 42-in. sheets in a thickness range from 1/16 to ½ in. Color is a natural grayish white, with a semi-gloss finish.

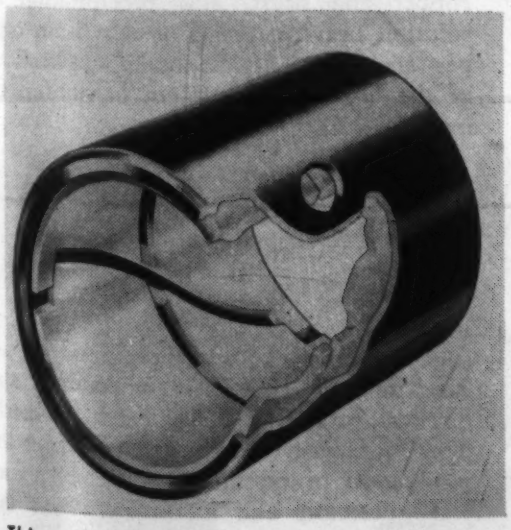
Black and Brown Urea Commercially Available

Commercial availability of a new low-cost black and brown urea plastic material has been announced by the Plaskon Div., *Libbey-Owens-Ford Glass Co.*, Toledo 6. The outstanding feature of the new compound is the fact that urea's excellent electrical and physical properties are now available in a price range below that of any standard molding compound. It sells at the price of 18¾c per lb for quantities over 20,000 lb.

Among the outstanding physical characteristics claimed for the new molding compound are its non-bleeding properties when immersed in water. Both black and the brown urea compounds are light fast. Moreover, color uniformity, the lack of which in other low-cost compounds has long plagued plastic molders, is guaranteed by the same rigid control that governs all grades of company products.

In growing commercial use, specifically in the manufacture of wiring devices, the new compound has proven its excellent stability and ease of molding. Its shrinkage is 0.006 to 0.014 in. per in., and it has an arc resistance of approximately 90 sec. In addition to wiring devices, the new compound is expected to find application in the manufacture of such other products as buttons, buckles, bottle caps, stove and refrigerator parts, premiums and electrical component parts.

Thinwall Nylon-Lined Bearings Developed



This nylon-lined bearing is corrosion resistant and can be submerged in most liquids.

A new type of nylon-lined bearing has been developed by *Thomson Industries, Inc.*, Manhasset, N. Y., which consists of a thin, drawn steel outer sleeve and a free floating liner of du Pont FM 10001 nylon. Called Standard Thinwall Nylined Bearings, they are being offered in ten sizes ranging from ¼- to 1¼-in. i.d.

Ordinary molded or machined nylon bearings have limitations due to the clearances required to allow for expansion due to temperature and moisture absorption, as well as distortion due to internal stresses. Also, plain nylon bearings cannot be press fitted, and they usually use more nylon for structural reasons than is necessary for a bearing surface.

The new bearings were developed to offer a low cost solution to these problems and to provide bearings of resilient material which resist poundout, decrease friction, permit dry operation, damp mechanical vibration and minimize abrasion failures. The new bearings are also corrosion resistant and can be operated submerged in most liquids.

The nylon liner, which is an instantly replaceable bearing surface, is provided with a spiral compensation gap which serves a dual purpose. It compensates for dimensional changes in the circumference due to expansion and contraction which would otherwise cause fluctuations in the bore diameter. In applications where lubrication is required, this gap also serves to distribute lubricant in an axial direction as it connects with the center circumferential lubrication slot which receives lubricant through the hole in the outer sleeve.

New Materials and Equipment continued

Specially Treated Rubber Offers Unusual Properties

The Linatex Corp. of America, Rockville, Conn., has announced the availability of Linatex, a special form of natural rubber made in Malaya. A patented process preserves the crystal structure of the rubber and additional properties that are said to be found only in this product.

The material is claimed to be completely resistant to moisture and to be three to four times more resilient than other rubbers. It is light in weight, having a specific gravity of 0.97. Resistance of the material to low temperature is outstanding, and, according to the company, its resistance to abrasion, corrosion and vibration is greater than that of metal or any other type of rubber or plastic.

Linatex can be attached or joined by a simple cold air cured type of cement. Permanent adhesion can be obtained to most surfaces, including metal, wood, concrete, fiberglass and other rubber surfaces. Another advantage is that worn parts can easily be repaired by cementing Linatex over worn surfaces. Where shock or vibration is a factor, the material proves useful. Pipes and valves that are lined with it show longer wear over unlined metal.

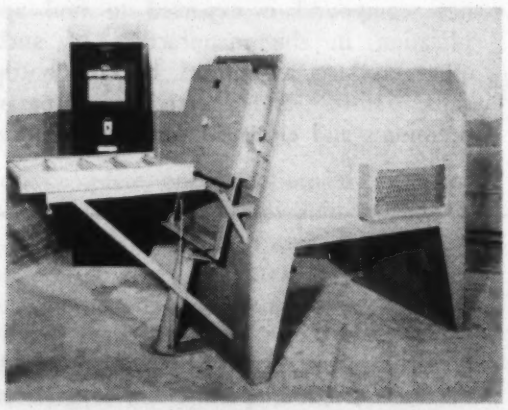
Typical industries already using the material are: mining, quarrying, dredging, coal handling, pulp and paper. Some typical applications are conveyor belting and pulleys, ore skips, tanks for holding acids, covering fan blades and lining housings.

Linatex is produced in sheet form in thicknesses of 1/32 to ½ in. Standard size sheets are 4 by 50 ft. However, sheets can be produced to any length or thickness.

Tempering Unit for Bright Tempering and Controlled Oxidation

A new unit which is said to make possible both bright, scale-free tempering and controlled oxidation tempering from 400 to 1400 F has been announced by *Ipsen Industries, Inc.,* 715 S. Main St., Rockford, Ill. Known as the Ipsen D-300 Tempering Unit, the sealed, controlled atmosphere furnace utilizes a completely new process of controlled oxidation developed recently.

For bright tempering, the unit is supplied during the entire cycle with a protective atmosphere. After sufficient time at temperature, the load is cooled in the furnace until it reaches approximately 400 F. The bright scale-free work is then cool enough to be removed from the furnace without danger of oxidation. The finish remains clean, bright and scale-free, and no cleaning or pickling operations are claimed to be necessary before subsequent plating or painting.



Scale-free tempering and controlled oxidation are made possible by this new unit.

The Ipsen D-300 also readily produces a controlled oxide coating, which is often desired to reduce corrosion or wear, and to produce an attractive blue-gray or blue-black appearance. This is accomplished either in a separate operation or concurrently with a tempering or annealing operation. The protective atmosphere is used to maintain a bright surface during any necessary tempering or annealing operations prior to the controlled oxidation cycle. It is, therefore, possible with the unit to maintain strict control over the oxidation process irrespective of the tempering or annealing portions of the cycle.

After the load heats or cools to the oxidation temperature, the flow of protective gas is discontinued and a predetermined quantity of water is introduced into the unit for a specified period. The work is then removed from the furnace and air-cooled or liquid quenched. During either air or quench cooling, further oxidation is prevented by the controlled oxide coating. The air-cooling produces a blue-gray coating and the oil quench forms a darker blue-black finish, due to the penetration of oil into the oxide film. This darker coating is more attractive and is considerably more resistant to corrosion. Either soluble oil or standard quenching oil can be used.

The new unit is also said to be excellent for use in tempering nonferrous metals because of ease in maintaining extremely uniform temperature. Many such metals are very sensitive to temperature differences, and often the tempering must be carried out close to the melting point of some of the softer metals and their alloys. Solution heat treatment of aluminum, annealing of copper and brass, and precipitation or solution heat treatment of beryllium copper are a few of the many applications of the D-300 in treatment of nonferrous metals.

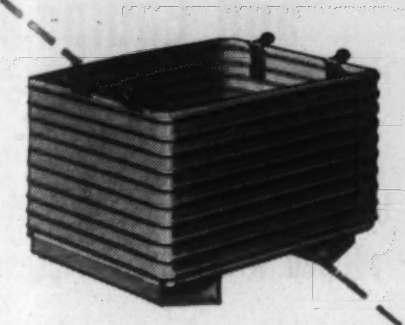
High Purity Silicon Powders for Microwave Crystal Manufacture

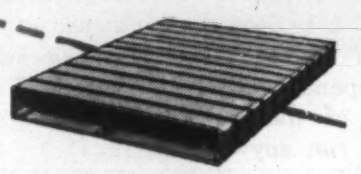
High purity silicon powders specially processed to meet the rigid chemical requirements for the manufacture of crystals for radar, video relay and other microwave applications, are now available from the Tungsten and Chemical Div., *Sylvania Electric Products, Inc.,* Towanda, Pa.

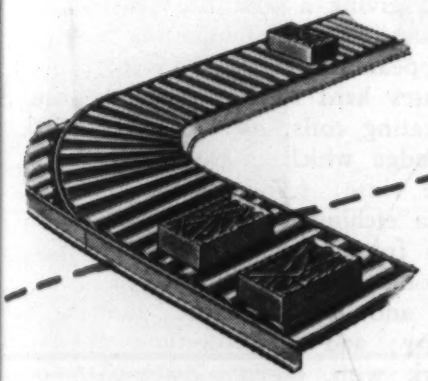
According to the company, the powders have purities of 99.85% and 99.95%, as compared to previous powders supplied with purities of 95.75%. The powders were developed in company laboratories to provide manufacturers with materials of highest purity commercially obtainable for the preparation of crystals used as the semiconductor element in crystal rectifiers for microwave receivers.

A new process was developed to assure uniform chemical composition and physical properties from batch to batch. This uniformity is expected to permit the production of crystals for use as microwave detectors and mixers in radar and video applications with a predictable range of electrical characteristics.

(*Continued on page 164*)

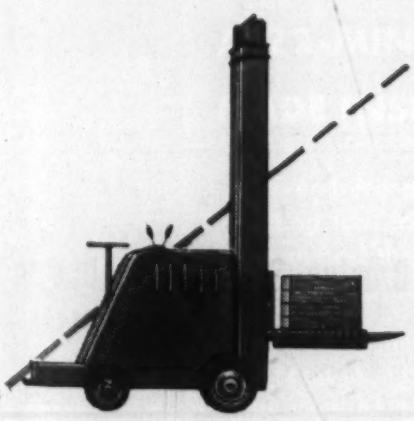






Handle materials better, more cheaply, with equipment made of

N-A-X
HIGH-TENSILE STEEL



Minimum product weight and long product service are just two important reasons why N-A-X HIGH-TENSILE steel is ideally suited for tote boxes, pallets, conveyors, lift trucks, and other equipment used for transporting materials.

Because N-A-X HIGH-TENSILE steel has exceptional strength and durability, thinner sections can be used, yet it resists abrasion, impact, fatigue, and corrosion. N-A-X HIGH-TENSILE steel gives your equipment longer life and reduces deadweight to the minimum; you can carry a greater net load of material with no increase in the gross load weight. And N-A-X HIGH-TENSILE steel has exceptional welding and fabricating qualities – important advantages where custom-made materials-handling equipment is required.

If you are interested in better, more economical materials-handling, why not investigate N-A-X HIGH-TENSILE steel *now?*

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division • Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet

Subject: HOW TO MAKE PAINT STICK TO GALVANIZED IRON WITH LITHOFORM®

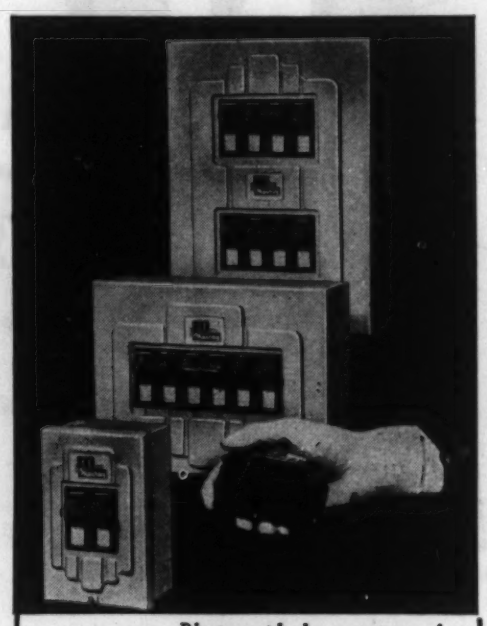
INTRODUCTION

"Lithoform" forms a dense, zinc phosphate coating on zinc, cadmium, and galvanized surfaces—including Galvanneal, cadmium plated steel, zinc plated steel, zinc base alloys, and zinc base die castings. The "Lithoform" coating, which is non-metallic and inactive, retards reaction between alkaline metal oxide and the paint film. Peeling and loss of adhesion are thus greatly retarded on painted Lithorized zinc and cadmium.

ADVANTAGES OF "LITHOFORM"

"Lithoform" forms a durable bond for paint. It is economical. It eliminates frequent repainting. It protects both the paint finish and the metal underneath. "Lithoform" meets these Government Finish Specifications:

QQ-P-416
RR-C-82
MIL-E-917A (Ships)
JAN-F-495
AN-F-20
U.S.N. Appendix 6



Photograph by courtesy of Murray Manufacturing Corp.

Murray Circuit Protectors are fully magnetic and provide maximum protection for both domestic and industrial wiring. Housings are of galvanized iron which is Spray Lithorized for long paint life.

THE LITHORIZING PROCESS

"Lithoform" can be applied by brushing or spraying the work with simple hand equipment, by dipping it in tanks, or by spraying it in industrial power washers.

Brush. Galvanized bay windows, cornices, rain gutters, hardware, building siding, truck panels, and farm equipment are typical of the many surfaces that are treated effectively with Brush "Lithoform".

Dip. This grade is used for coating cleaned surfaces of such typical products as cabinets, refrigeration condensers, etc., immersed in heated solutions in tanks.

Spray. The spray process is the most logical one with which to coat sheets, coiled strip or duplicate products best processed on a conveyor.

CHEMICALS ACP PROCESSES

WRITE FOR FURTHER INFORMATION ON "LITHOFORM" AND ON YOUR OWN METAL PROTECTION PROBLEMS.

CHEMICALS ACP PROCESSES

New Materials and Equipment

Uniform Etch on Aluminum Produced with New Compound

Oakite Products, Inc., 132H Rector St., New York 6, has announced the development of Oakite Composition No. 60, a material designed to produce a heavier and more uniform etch on aluminum. A white granular powder which is readily soluble in water, the composition should be used at concentrations of 2 to 6 oz per gal at temperatures between 140 to 180 F. Time of immersion depends entirely on the depth and quality of the etch desired. Immersion periods run anywhere from 15 sec to 2 min. A hot or cold rinse completes the etching process and the parts are then desmutted in the regular sequence.

Outstanding advantages claimed for the new material are: (1) it etches rapidly, giving a controlled etch of any depth desired, while imparting a velvet-like appearance to the surface; (2) it eliminates hard scale build-up on tanks and heating coils, leaving only a light, soft sludge which is easily removed by a hose rinse; (3) provides consistent, uniform etching without excessive foaming or fuming; (4) working solutions have long life, run two, three or four weeks and longer before dumping is necessary; and (5) solutions are easy to work with, do not become clouded with suspended matter.

Brazing Sheet Finds Use in Automotive Radiators

Aluminum Co. of America, 801 Gulf Bldg., Pittsburgh 19, has announced development of a new aluminum alloy brazing sheet which will find immediate use in automotive radiator development work, and which, upon investigation, may prove a boon to many other applications of aluminum.

The new product, No. XA30 Brazing Sheet, has a core metal of 3S alloy. One side of the core metal is clad with C43S brazing alloy to assure good joints, and the other side has an alclad coating which offers electrolytic protection to the core. The alclad coating, which is on the thinner side of the radiator tubing, goes a long way in providing corrosion protection.

Several different corrosion test methods have been used on the new No. XA30

Alloy Rods Co.

LOOK FOR THE FLAMING ARC TRADEMARK

ALLOY RODS COMPANY

The Leading Manufacturer of Alloy Arc Welding Electrodes

PRESENTS

THE FIRST "INSIDE STORY" FILM

OF HOW ARC WELDING ELECTRODES ARE MADE

"No Finer Electrodes Made... Anywhere"

A 22-MINUTE SOUND MOTION PICTURE IN FULL COLOR MADE INSIDE ALLOY RODS' YORK, PENNSYLVANIA PLANT

Never before to our knowledge, since arc welding became of age as a major fabricating tool for American industry in the early 1930's, has any electrode manufacturer permitted the public to see how coated arc welding electrodes are made. The manufacturing processes and procedures have always been carefully guarded trade secrets.

Now, for the first time, *Alloy Rods Company* has filmed its entire manufacturing process in the interests of better trade relations and technical understanding . . . from the cold drawing of hot rolled rod to the packaging of its finished electrodes in moisture-proof metal containers. You can now see how arc welding electrodes are made.

"No Finer Electrodes Made . . . Anywhere" is not a sales film or promotional tool. It is technical and instructional . . . shot on the production lines and in the laboratories . . . to show those interested in better arc welding *why* we make electrodes this way. Prints of this film are available, without charge, to any reputable organization or institution.

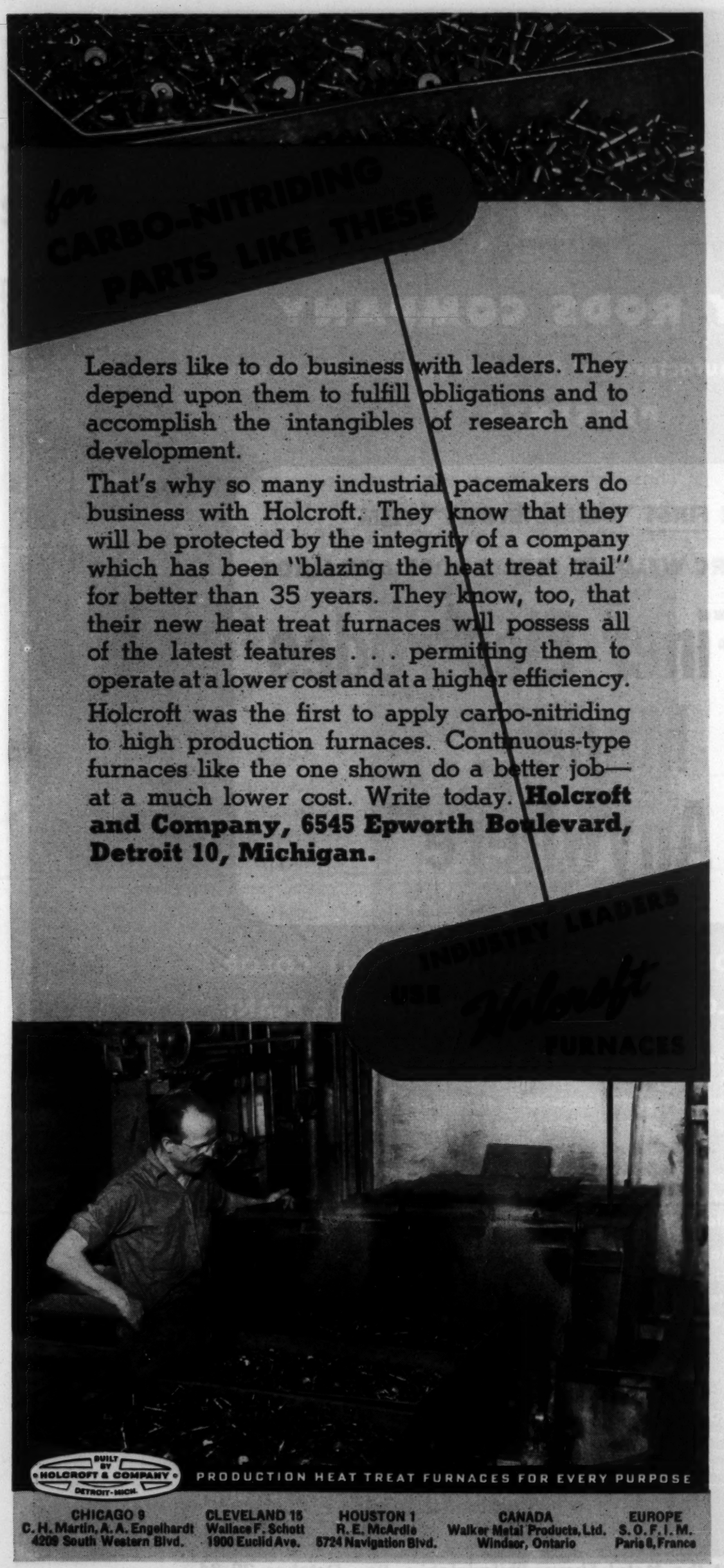
WRITE, WIRE, OR TELEPHONE to Department M if you would like to use this film for any organizational or educational purpose. We will try to have a print available to fit your next open date.

ALLOY RODS COMPANY
YORK, PENNSYLVANIA

NO FINER ELECTRODES MADE . . . ANYWHERE

AR-12

WORLD PREMIERE • At the Metal Show, Philadelphia, Pa., October 20-24, 1952 . . . showing every hour on the hour, Alloy Rods' Exhibit, Booth 448, Arena.



New Materials and Equipment

brazing sheet. Accelerated corrosion tests were run and solution potential measurements were made with synthesized waters simulating the water of special areas of the country which might cause attack in aluminum radiators. Tests were conducted with water only and then with each kind of water in combination with varying percentages of anti-freeze compounds. One water formulation had a significant concentration of heavy metal salts. Another had a relatively high chloride content. Both ethylene glycol base and alcohol base anti-freeze solutions were tested in this manner. Test results indicated that corrosion by the coolant mediums described was not critical in the new sheet.

Undercoating Has Good Adhesion and Corrosion Resistance

A new industrial undercoating meeting the requirements of Federal Specification TT-C-520, has been announced by the Adhesives and Coatings Div., *Minnesota Mining and Manufacturing Co.*, 411 Piquette Ave., Detroit 2. A tough, sprayable black-asphalt material called EC-1189, the coating is designed to protect underbody parts of transportation equipment from corrosion and abrasion, and for various industrial anti-corrosion, weathering and sound deadening jobs.

For corrosion control it can be used to protect metal buildings in fertilizer, paper pulp, plywood and chemical plants. Also, to protect the exteriors of storage tanks, tank trucks and railroad cars against spillage and water and soil corrosion.

For weathering protection, the coating can be used on power plant roofs and walls; exteriors of railroad signal bungalows; and the bottom exteriors of outdoor switchgear housings.

For sound deadening, it can be used inside barge deck houses and engine rooms; in the sound trap of air conditioning units and the duct work of air diffusers; and on the interior panels of trucks, railroad cars, metal caskets and table tops.

Properties are said to include: good adhesion to most materials and surfaces, and excellent resistance to water, salt water, and other corrosive agents. When sprayed or brushed to a ⅛-in. thickness, it dries in about 48 hr to form a tough rubbery "hide."

A FAMOUS Name in Pumps Specifies a FAMOUS Name in Materials...

NO one familiar with industrial products will deny that Vickers, Inc., Detroit, Mich. is truly a famous name in pumps and all types of hydraulic equipment.

Among the many important types of pumps produced by Vickers is the combination Vane-Type Pump (Fig. 1). In this high pressure unit designed for compactness for successful operation in limited space it is obvious that the housing or body (Fig. 2) would have to be produced in a metal which would provide regularly and dependably pressure tightness, high tensile strength, uniformity, freedom from defects and good machinability. It is for these reasons that Vickers regularly specify Meehanite castings.

The name Meehanite Metal has also earned itself fame among design engineers, production executives, management and purchasing officers who concern themselves with the selection, specification and procurement of component parts and materials requiring the maximum, both property and quality-wise.

Whether your castings require density and pressure tightness; or high tensile strength; or heat treatability for toughness and wear resistance; investigate the wide range of materials available in Meehanite castings.

Remember that Meehanite "Bridges the Gap" between cast iron and steel!

Take *YOUR* Casting Problem To A MEEHANITE FOUNDRY

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Toledo, O.
Builders Iron Foundry	Providence, Rhode Island
Compton Foundry	Compton, Calif.
Continental Gin Co.	Birmingham, Alabama
Crawford & Doherty Foundry Co.	Portland, Oregon
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Empire Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hardinge Company, Inc.	New York, New York
Hardinge Manufacturing Co.	York, Pennsylvania
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

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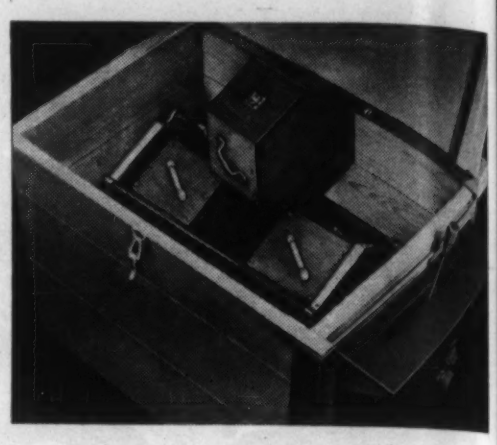
New Materials and Equipment



Pocket Tumblers for Small Parts

Tumb-L-Matic, Inc., 4510 Bullard Ave., New York 70, has announced a new tumbling barrel having individual pockets for tumbling from 2 to 6 items at a time. The Pocket Tumbler is recommended for deburring, precision finishing and polishing small metal parts.

Typical items for which the tumblers can be used include jewelry findings, ornaments, stampings, screw-machine parts and gears. Model makers, jewelers, experimental laboratories and instrument manufacturers are typical users.

The unit comprises a rotating container, or frame, into which the pockets fit. Both the pockets and the frame are hexagon-shaped. The frame is enclosed on five sides during tumbling to hold the pockets in. One side of the frame opens to permit pockets to be inserted and removed.

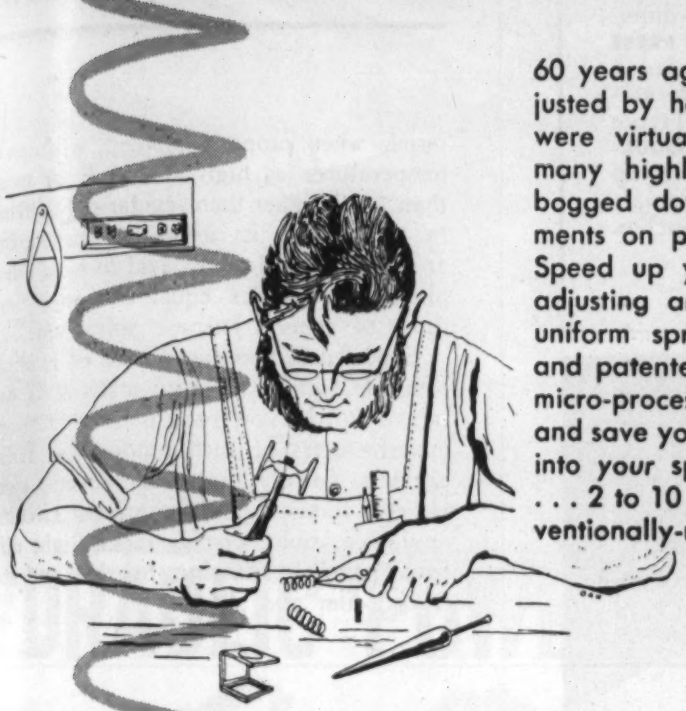
Pockets are equipped with handles for ease of handling. They open on the side adjacent to the handle. By having an extra supply of pockets, loading and unloading can be accomplished while other pockets are being tumbled and a near continuous batch operation can be achieved. Tumblers are available with frames for handling from two to six pockets. Pockets range from 12 to 16 in. in dia.

New Polystyrene Withstands Temperatures as High as 220 F

The Dow Chemical Co., Midland, Mich., has announced development of a new heat resistant addition to its Styron family of plastics which is expected to find use in applications never before utilizing polystyrene plastic due to temperature limitations.

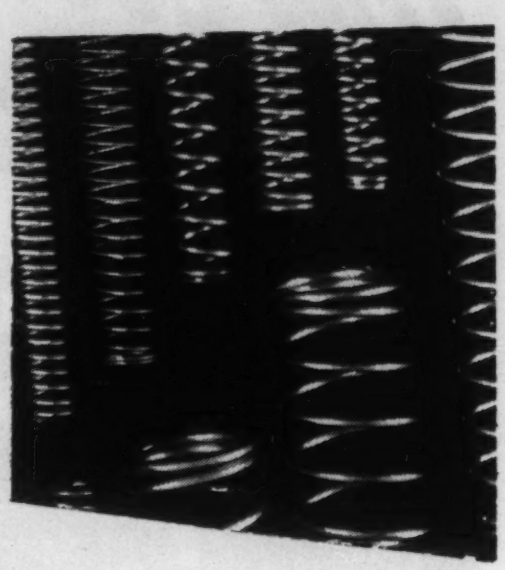
Known as Styron 700, the new ma-

Is your production tied down to 1890 springs?



60 years ago, springs were made and adjusted by hand. Performance qualifications were virtually unknown. But even today, many highly-geared production lines are bogged down by expensive hand adjustments on precision springs.

Speed up your production—eliminate your adjusting and testing costs with I/S ultra-uniform springs. I/S exclusive techniques and patented equipment give you certified, micro-processed, beryllium copper springs—and save you valuable man-hours. We build into *your* springs, the properties *you want* . . . 2 to 10 times more accurately than conventionally-made springs.



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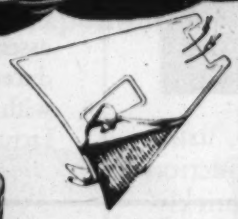
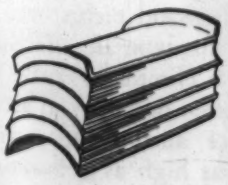
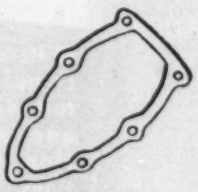


ELECTRIC HEATING UNIT — Made from laminated silicone rubber fiberglas and resistance wires to prevent ice formation on jet engine doors.

HINGE BEARINGS — Shock mounted to prevent bearing and strut failure due to vibration.



MOTOR MOUNT — Isolates vibration of Pratt and Whitney Aircraft engine from rest of airplane.



BOMB BAY DOOR SEAL — Made of silicone rubber to resist —100°F temperatures of arctic and stratospher

PRATT & WHITNEY PARTS — Custom fabricated for the world's most powerful reciprocating engine.

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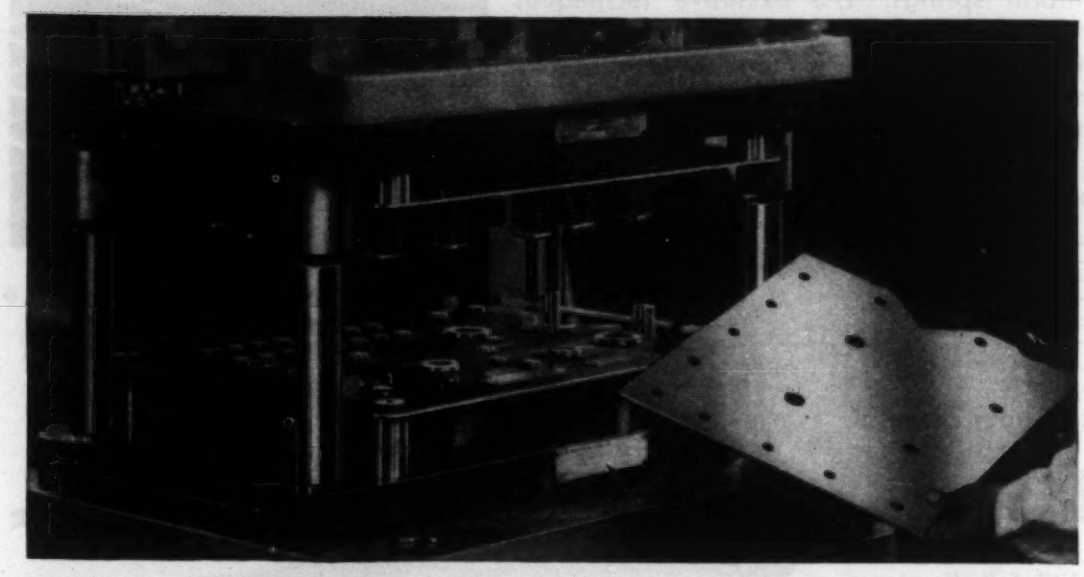
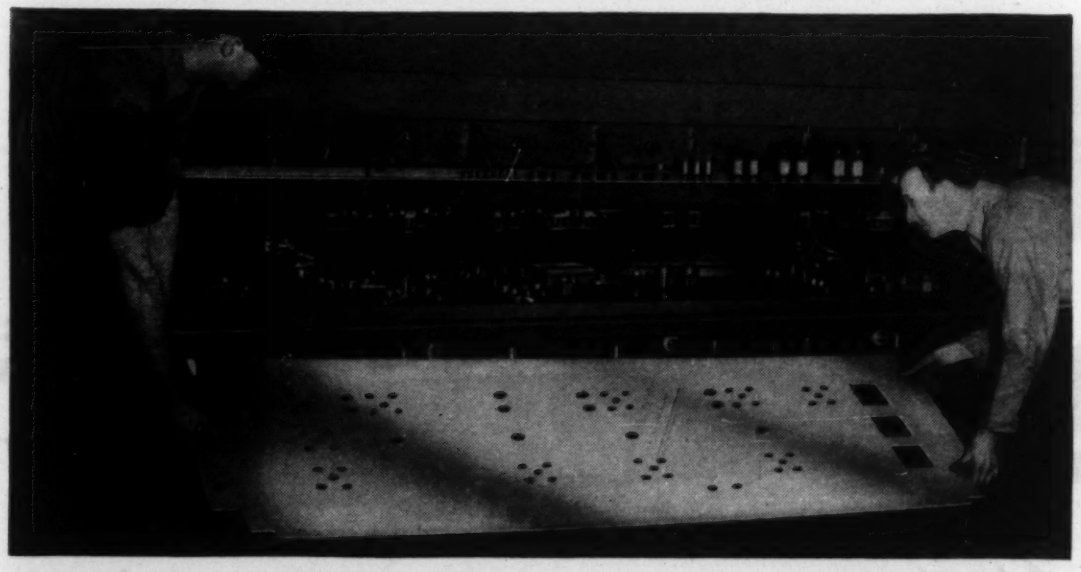


Whistler *MAGNETIC* Dies at work in large inclinable press. Magnetized retainers hold the units. No bolting required. A fast, economical method in making up a punch and die set for short or long runs. All parts re-usable.



Whistler *ADJUSTABLE* Dies on perforating and notching job, using Tee slotted die set. With Whistler Adjustable Punch and Die units production starts within hours instead of weeks. Last minute job changes made quickly.

● Here are the complete details with prices and application illustrations. Send for these catalogs. No obligation.

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S. B. WHISTLER & SONS, Inc.

Adjustable, Magnetic, Custom and Cam Dies for all Industry

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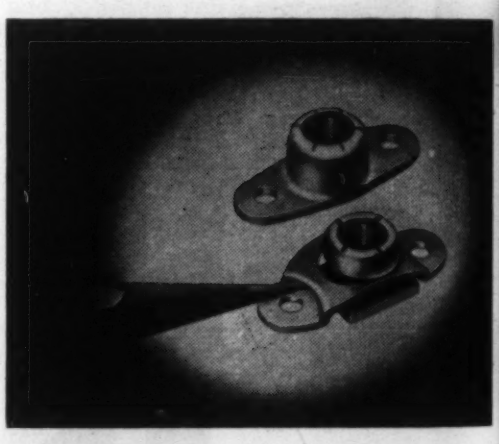
New Materials and Equipment

terial, when properly molded, withstands temperatures as high as 220 F, or more than 20 F higher than regular polystyrene. In addition to its improved heat resistance, the new plastic is said to have other physical properties equal or better than those of general purpose polystyrene.

Expected to open new fields of application for Styron, the new material is expected to be of particular interest to manufacturers of such products as radio cabinets, battery cases and covers, electric coil forms, bases for printed circuits, appliance knobs, display racks, light diffuser panels, packaging, bristles, and extruded film and sheet.



Floating Anchor Nut Saves Cost, Time, Weight

Quick self-alignment and simplified assembly of aircraft components at reduced costs is now said to be possible with a new floating anchor nut manufactured by *Elastic Stop Nut Corp. of America,* 2330 Vauxhall Rd., Union, N. J. According to the company, weight savings of 1.3 lb per thousand pieces over earlier anchor nuts of this type are effected. Use of the nuts also eliminates costly lining-up operations often necessary to accurately install one-piece anchor nuts, with reported savings as high as 3 to 4c a unit.

Recent redesign of its old type floating anchor nut by company engineers permitted them to give the new A-41 smaller over-all dimensions than were possible before. As a result, it is the same size as the firm's standard non-floating anchor nut and complies with an AN 366 dimensional and performance requirements.

A special feature of the new part is the offset shoulder on the anchor lug which assures full floating action of the nut by preventing interference between it

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W-S Hydraulic Press flexibility of control is a natural for the precision required in shell forging manufacture. Combine this control with the economy of using only the press tonnage and stroke required and the exactly suitable speed and you have the answer every pressing operation.

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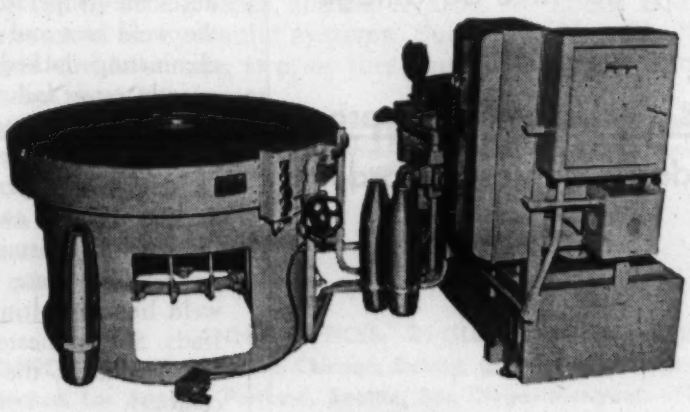
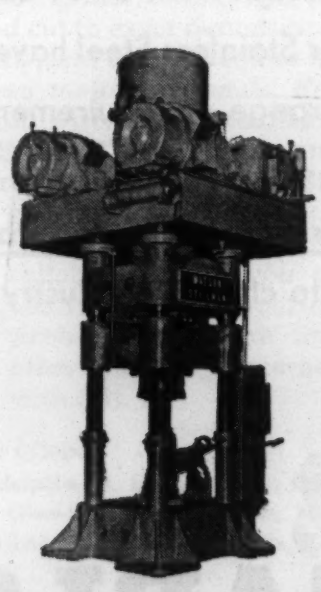
Write now specifying your type and size of shell for today's W-S Press recommendations . . . it's backed by 104 years of hydraulic experience.

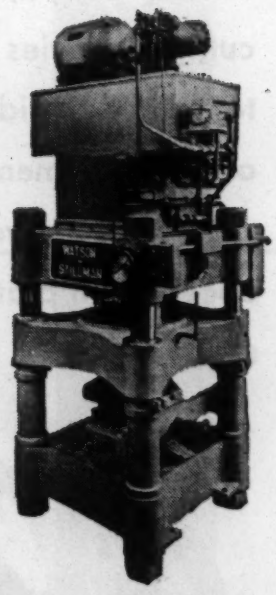
Shell Piercing Press



Shell Bander



Shell Nosing Press



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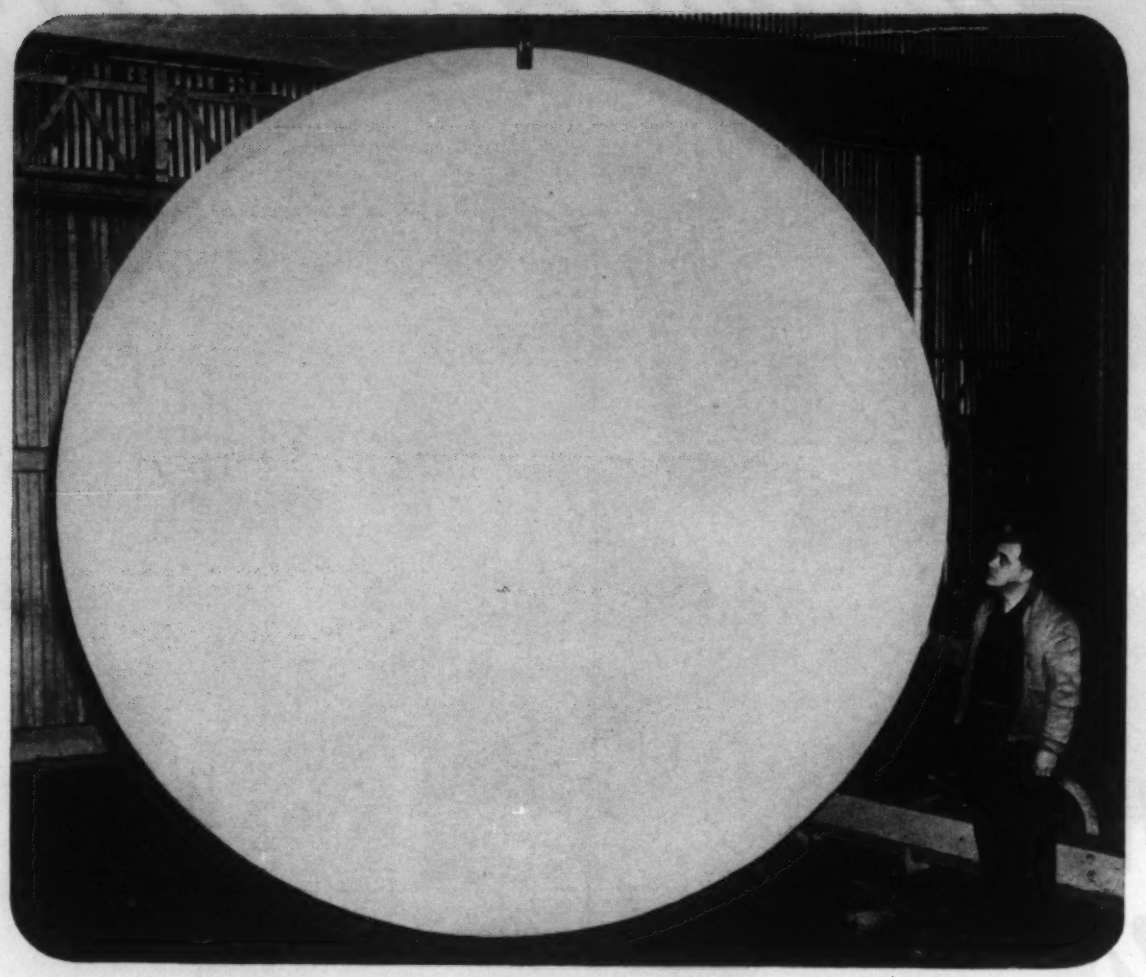

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Cutting Stainless Steel to shape is easy—when you have the proper equipment.

G. O. Carlson, Inc. regularly supplies diameters from our own plate in sizes ranging from less than one inch to the world's largest —to your precise specifications, in any thickness.

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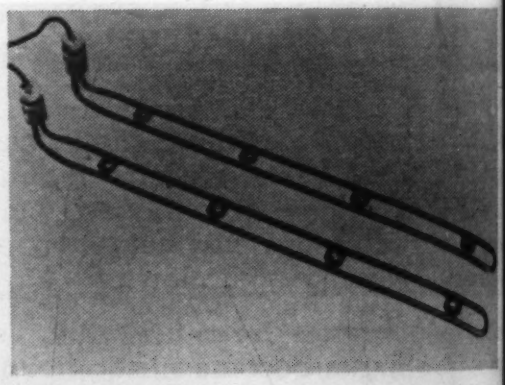
New Materials and Equipment

and the two rivets holding the lug to a part or assembly. It is claimed that the nut's smaller external dimensions will permit aircraft manufacturers to use it in place of nonfloating types for such applications as fastening wing tips to outer wing panels, where space limitations do not always permit use of the larger floating anchor nuts. The interchangeability of the A-41 with AN 366 parts also offers the aviation industry the opportunity to reduce fastener inventories by standardizing the item, since floating nuts are used to fasten many other parts of airframes.



Tubular Heater Eliminates Locked-In Stresses

Designed as an aid in welding steel pipe and plate, the new electric tubular heater offered by *Edwin L. Wiegand Co.*, 7523 Thomas Blvd., Pittsburgh 8, reduces the temperature differential between the weld area and adjacent metal, thereby eliminating locked-in stresses that frequently cause failure of welded parts. By placing the heaters between the weld line and larger sections of cold metal, a "heat dam" is formed which slows conduction of heat away from the weld. In the case of a straight line weld, heaters are held in place about 6 in. from the weld line by bolting them to tack-welded studs. Special heater shapes are similarly attached to fit the heat to various weld contours.

The heater elements are triangular in cross-section, and one flat side is in contact with the work to give fast and efficient heat transfer. The triangular construction is also said to give good physical strength to the heater for this rugged type of work.

In operation, the heaters are turned on before welding begins until a temperature

AMERICAN FELT REALLY SEALS!

Shown above is an OilFoil seal, consisting of two layers of felt, bonded with two septums of Hycar, the synthetic rubber-like substance that is impervious to and unaffected by oils, greases, and the hydrocarbons used in hydraulic systems. Such washers can have one, two, or three septums, to keep lubricants in and seal out water, dirt, gases and retain pressures. If there is no lubricant in the enclosure, the felt can be impregnated with oil or grease, to provide lifetime bearing lubrication. OilFoil seals are supplied cut to exact dimensions, ready for assembly, and usually require no attention between major overhauls. For more information, write for Data Sheet No. 11, "Felt Seals, Their Design and Application." Free. American Felt's Engineering & Research Department will gladly collaborate with you on sealing and lubrication problems, and on any other matters concerned with felt.

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Carbon ground rods
Electrical contacts
Carbon piles
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Write for your copy of this 44-page book. Besides describing Stackpole products, it contains data on the amazing versatility of carbon and graphite in modern equipment.

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EVERYTHING IN CARBON BUT DIAMONDS
STACKPOLE CARBON COMPANY
St. Marys, Pa.

New Materials and Equipment

of 400 to 500 F is attained in the weld zone—and they are left on after welding is completed. These pre-heating periods vary according to type and thickness of the metal.

Results of controlled heating and cooling are said to include: (1) improved quality of the weld. With slower cooling the amount of weld metal can be controlled more accurately to assure correct thickness of weld at the first pass and a hard, brittle joint caused by rapid cooling is avoided. (2) Preheating drives off surface moisture, assuring better adhesion of weld deposit. (3) Distortion and residual stresses are reduced as heated metal is more ductile and can stretch toward weld as weld contracts.

New Solution Inhibits Corrosion of Mild Steel

Protection of mild steel from corrosion after cleaning is now said to be achieved by the application of a recently developed homogeneous solution manufactured by *Kelite Products, Inc.*, 1250 N. Main St., Los Angeles 12. Known as Kelite M-2, the product is claimed to be superior to petroleum oil used for the same purposes since it affords vastly superior corrosion inhibiting properties, eliminates the need for drying prior to treatment, and is impervious to finger-printing.

Kelite M-2 can be applied by immersion, spray or brush. It is nonflammable (flash point 140 F), nonphenolic and nontoxic. It will not burn the skin and its vapors are not harmful.

Said to be most outstanding of its qualities is a unique ability to displace and absorb up to 11% of its own volume in water without impairment of efficiency. It is this quality which makes it possible to eliminate the drying operation prior to treatment.

Improved Heat Sealing Compounds

Glyco Products Co., Inc., 26 Court St., Brooklyn 2, has announced improved heat sealing compounds. Heat sealing compounds, in addition to good sealing properties, frequently must meet other severe

. . . THE WIRE THAT GETS *Bouquets* FROM FLORISTS

Florists tell us they like the medium-dark straw color of Continental florist wire. They say it blends beautifully with artistic floral arrangements . . . is exceptionally easy to work with because it is dead soft . . . does not easily discolor in water or air. That's the way it is with all types of Continental wire—from the lightest to the heaviest gauges. All are made just right for the job. You are sure to like Continental wire and particularly Continental's helpful wire service. If you have a wire problem, we are anxious to help you solve it. Write us about it at Kokomo, Indiana.

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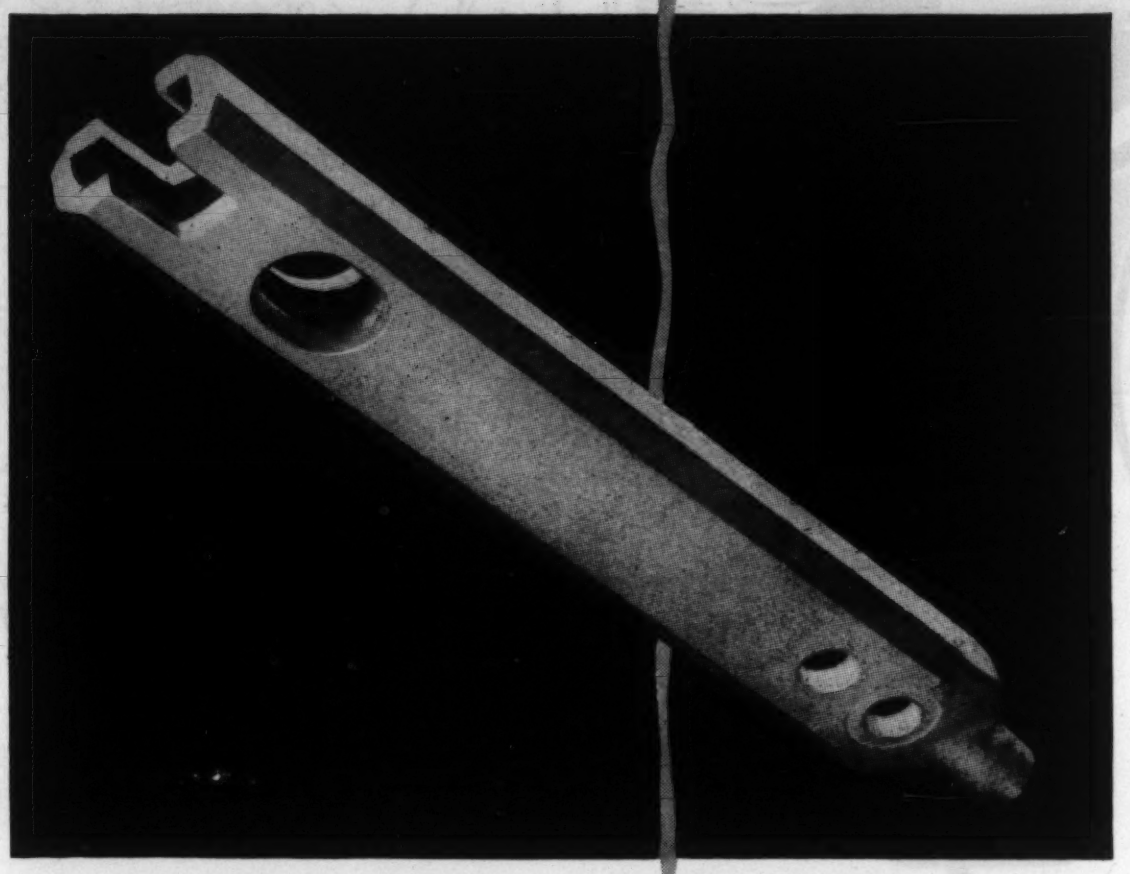
UCERS OF *Manufacturer's Wire* in many sizes, s, tempers and finishes, including Galvanized, KOKOTE, Flame-Sealed, Coppered, Tinned, Annealed, Liquor Finished, Bright, Lead Coated, and special wire. ALSO, Coated and Uncoated Steel Sheets, Nails, Continental Chain Link Fence, and other products.

Say "when"



75¢ for this *Investment Casting*, compared to a former $2.17—same tool steel alloy, no machines or labor tied up producing it, and a more reliable product than before.

Previously machined as two halves from solid stock, it was then assembled by welding, milled and drilled. We *pour* the assembly as you see it here, ready for a few finishing touches.

Our use of expendable patterns gives the designer free rein, because we cast in almost any shape—many that can't be produced by any other process. We cast 160 ferrous and nonferrous alloys; a fraction of an ounce up to 5 pounds.

SEND FOR THIS FREE BOOK

It describes the tremendous possibilities of the process and our facilities for helping you design and produce parts as investment castings. Write Precision Metalsmiths, Inc., 1077 E. 200th St., Cleveland 17, Ohio.

when it looks impossible to cast

when machining costs are "out of sight"

when the alloy is a tough one

pour yourself an assembly with

PRECISION METALSMITHS INC.

INVESTMENT CASTINGS

New Materials and Equipment

specifications. Acrawax C, a high melting point (284 to 290 F) synthetic wax is said to raise the melting and cold flow points of such compositions without reducing adhesion and cohesion at low temperatures. Water, salt spray and chemical resistance are also increased.

A formulation for such heat sealing compounds is available. It has a high melting point (cold flow, 210 F min) and does not exhibit cracking or flaking at —45 F. The compound is noncorrosive and forms an efficient sealing barrier against leakage of air and moisture. It is resistant to water and salt spray.

Adaptable to a wide range of sealing applications where these properties are important, this sealing compound is particularly useful for sealing lenses in optical instruments and other glass units.

Improved Resin for Chemical Resistant Applications

A greatly improved resin used as a chemical resistant cement which is said not only to provide higher tensile strength and less shrinkage, but also to provide improved resistance to oxidizing solutions, has been announced by the *Irvington Varnish and Insulator Co.*, Irvington 11, N. J.

Known as Fura-Tone 1347, the resin will not crack, check or warp, such as is common with furfuryl alcohol resin. According to the company, it also exhibits a notable improvement in shrinkage.

The new resin can be substituted for furfuryl alcohol resins for lining tanks, or as a cement for chemical bricks to obtain superior chemical and physical properties.

(*More News on page 179*)

New Materials and Equipment

Abrasive Polishing Belt for Metals and Nonmetals

A new coated abrasive polishing belt that uses granulated cork rather than conventional mineral grains for obtaining a very high luster on glass, ceramics, metal and plastic has been announced by *Minnesota Mining and Manufacturing Co.*, 900 Fauquier St., St. Paul. Designated the 3M Wetordry brand polishing belt, it is designed primarily as a glass edge-polishing tool, although it is expected to find numerous applications in various other fields. The belt is designed to replace the conventional buffing wheel and cork set-up wheels, eliminating set-up time and resulting in faster polishing, higher finishes, and lower costs.

The cork surface of the belt is sized with resin combined with a polishing agent that is said to improve the polishing action. The belt is made with a water-proof cloth backing to which the cork granules are resin-bonded. Water is recommended as a lubricant in glass grinding operations and oil or grease for use with metal.

Used with the regular abrasive grit

'Surface'

USED FOR GALVANIZING pails, furnace is set in the floor. Heat from 'Surface' direct-fired burners is thoroughly controlled. Bath temperatures are maintained so that rapid erosion of kettle and hot spots on kettle walls are prevented.

Controlled HIGH HEAT input

for your galvanizing operation!

PRECISE, CONTROLLED HIGH HEAT INPUTS are essential for economical batch or continuous galvanizing . . and dependable part and product galvanizing results from a 'Surface' galvanizing furnace, because alloy layer is accurately controlled.

1. DIRECT-FIRED BURNERS above supply sufficient heat to compensate rapidly for heat losses due to addition of cold work and spelter to bath.

2. MINIMUM DROSS FORMATION results from the completely uniform and thoroughly distributed heat provided by direct-fired burners. This allows complete, satisfactory adhesion of coating to stock, maximum kettle life.

SETTINGS to meet all batch and continuous production requirements can be supplied.

WHEN NEXT YOU have a galvanizing problem, a 'Surface' industrial engineer will gladly discuss it with you. Better yet, write now for complete information. No obligation, naturally.

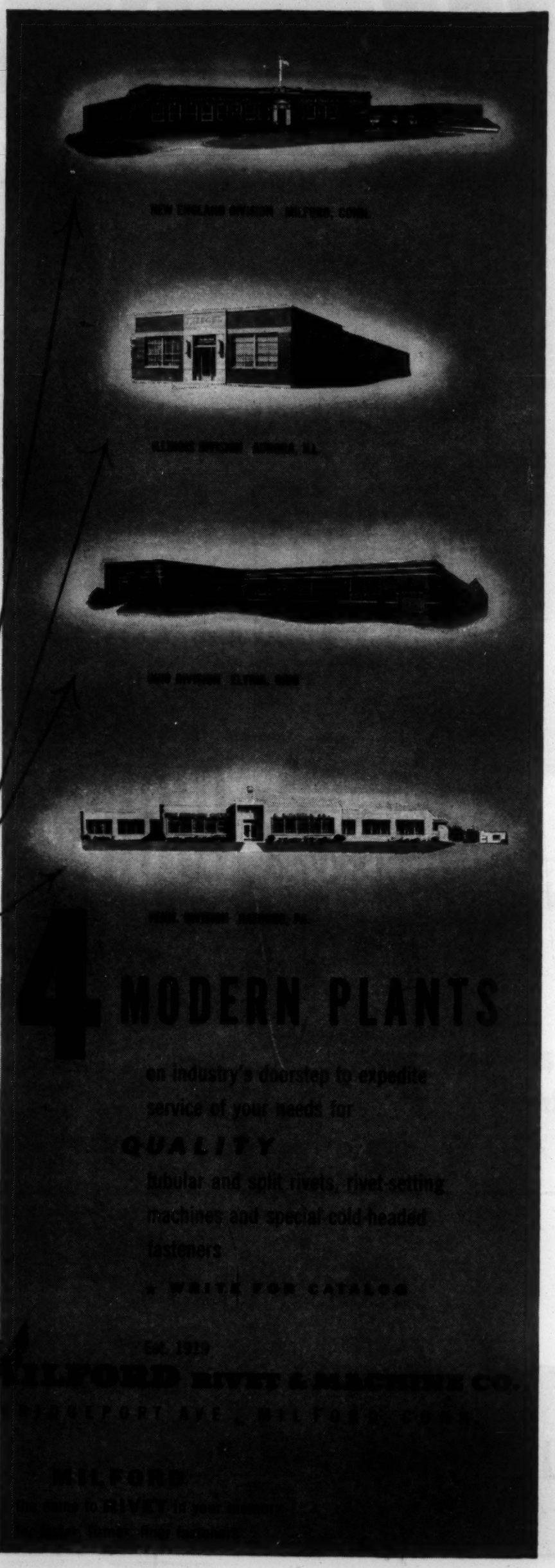
SURFACE COMBUSTION Corporation

TOLEDO 1, OHIO

'Surface' INDUSTRIAL FURNACES AND BURNERS

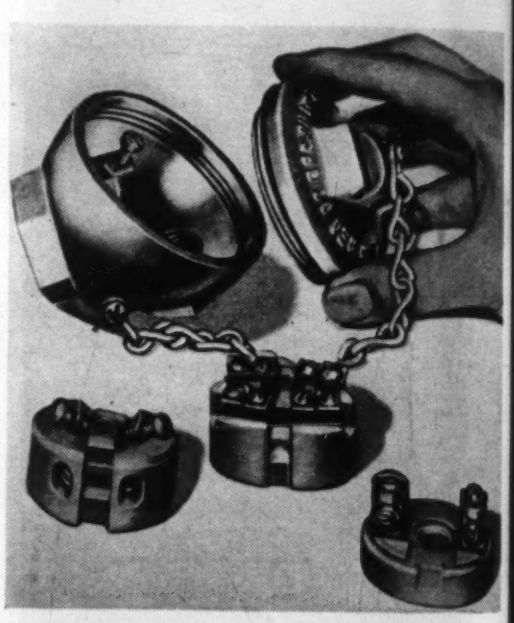
Kathabar HUMIDITY CONDITIONING SYSTEMS

Janitrol AUTOMATIC HEATING EQUIPMENT



New Materials and Equipment

sequences in the grinding and polishing processes, the belt makes for a greatly improved surface finish. It is available in a single universal surface in all standard sizes for existing belt grinding and polishing equipment.



New Developments in Pyrometer Accessories

Several new developments in pyrometer accessories have been announced by the Industrial Div., *Minneapolis-Honeywell Regulator Co.*, Wayne & Windrim Aves., Philadelphia 44. Among the new numbers the company reported three new types of insulated thermocouple wires and a new screw cover thermocouple head.

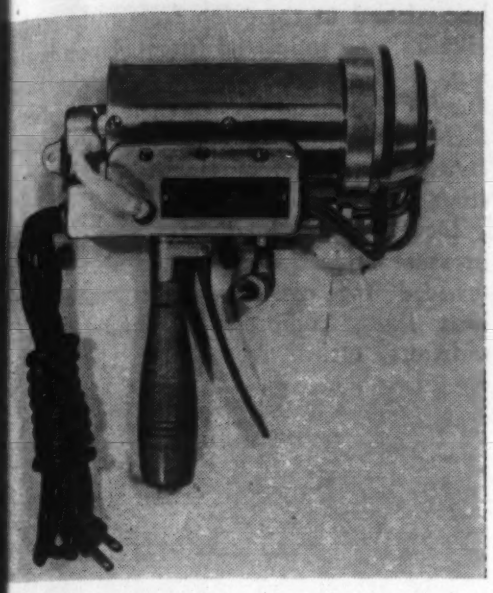
The new wires are for sub-zero temperature measurements, for refrigeration and air conditioning work, engine test cell applications, and for food canning involving heat-penetration studies, the measuring of canning retort temperatures and others.

The latest wire additions include insulation made of plasticized vinyl chloride for ambient temperatures between 20 deg below zero and 225 above F, a non-impregnated glass for ambient temperature up to 1200 F, and a fibrous silica for ambient temperatures up to 2000 F.

The new screw cover thermocouple head, for power generation, refinery, chemical, glass and ceramic plants, will not freeze or rust. It can be used for single or duplex thermocouple or high resistance thermometer elements.

(*More News on page 183*)

New Materials and Equipment



Spray Gun for Low Melting Alloys and Metals

Cooper Alloy Foundry Co., Hillside 5, N. J., has announced an improved model of their compact, simplified spray gun designed for the spraying of low melting alloys and metals. Also called Spray King, the new gun supersedes the original model and was designed to be used for a wider range of materials.

In addition to its internal heating element, the unit has a specially designed nozzle heating element which prevents metal cooling at the nozzle and assures continuous uniform spray. It is felt that the new gun will provide the answer to those marginal alloys in the 500 to 650 F class, which have always been difficult to spray.

Suitable for intermittent or production spraying, the gun is recommended for patternmakers, rectifier manufacturers, dental supply houses, precision casting companies, tool and die divisions and maintenance and repair men.

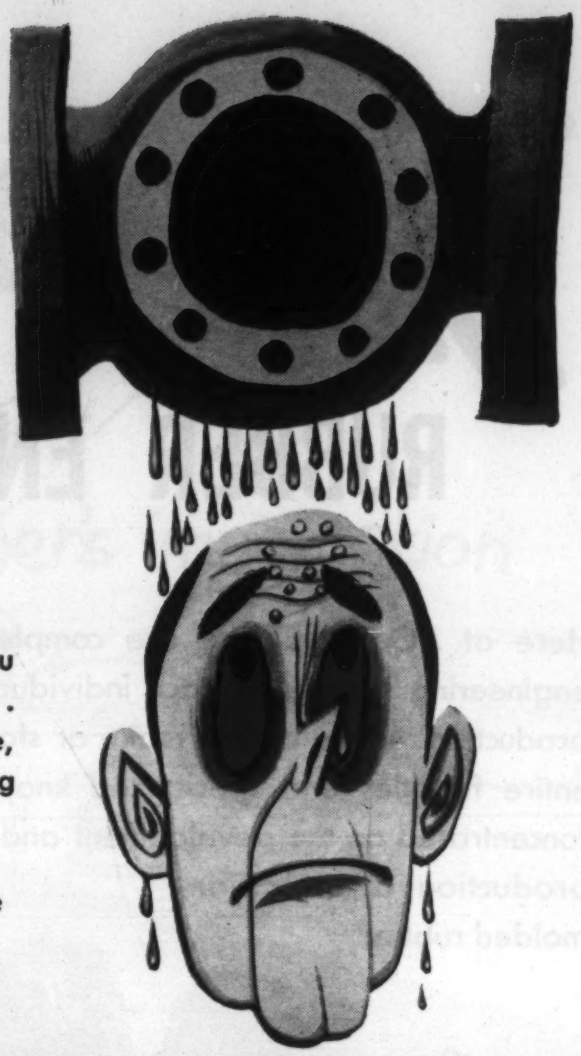
Copper Paint Has Extra High Heat Resistance

A new gold-colored extra high heat resistant paint, known as Heat-Rem XG-170 Gold, has been announced by *Speco, Inc.*, 7308 Associate Ave., Cleveland 9. Made of copper flakes in a silicone base, the paint will withstand temperatures up to 1700 F, according to the manufacturer, and will air dry in approximately 30 min.

Because of its high copper content, the

do you have

porosity neurosis?



Worried by leaking castings? Do you feel like this harrassed character . . . material losses, wasted machine time, lowered production and billing piling up on you?

Take the ***proven*** **POLYPLASTEX** cure

...reclaim rejects

...impregnate microporous castings

the POLYPLASTEX way...

POLYPLASTEX Sealants, Methods and Service combine to correct microporosity in all metals — ferrous and non-ferrous. . . .

FIRST 100% SOLIDS SEALANT No evaporation losses — Highest degree of sealing efficiency insured.

PHYSICAL AND CHEMICAL PROPERTIES **POLYPLASTEX** sealants withstand extremes of temperature and pressure, harsh solvents and corrosive chemicals. Approved and used by industry and military services.

METHODS **POLYPLASTEX** research and experience insure economical and fool-proof results. Critical tolerances not affected. Process leaves no surface film or stain.

POLYPLASTEX IMPREGNATION SERVICE AVAILABLE IN KEY INDUSTRIAL CENTERS Skilled, prompt and economical, Impregnation Service conforms to all military specifications.

See our exhibit at the METAL SHOW in Philadelphia, October 20-24, Booth No. 927, Center Building, Convention Hall

POLYPLASTEX INTERNATIONAL, INC.

441 MADISON AVE., NEW YORK 22, N.Y.

LICENSEES THROUGHOUT THE WORLD

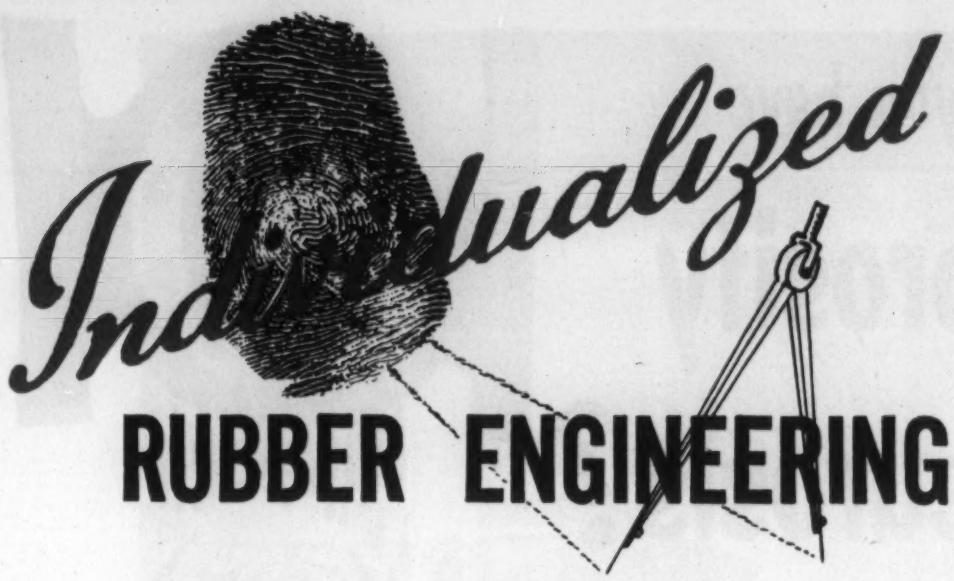
A POLYPLASTEX Castings Clinic is nearby. If you need immediate service or consultation, fill in coupon and mail today.

NAME _____ TITLE _____

COMPANY _____

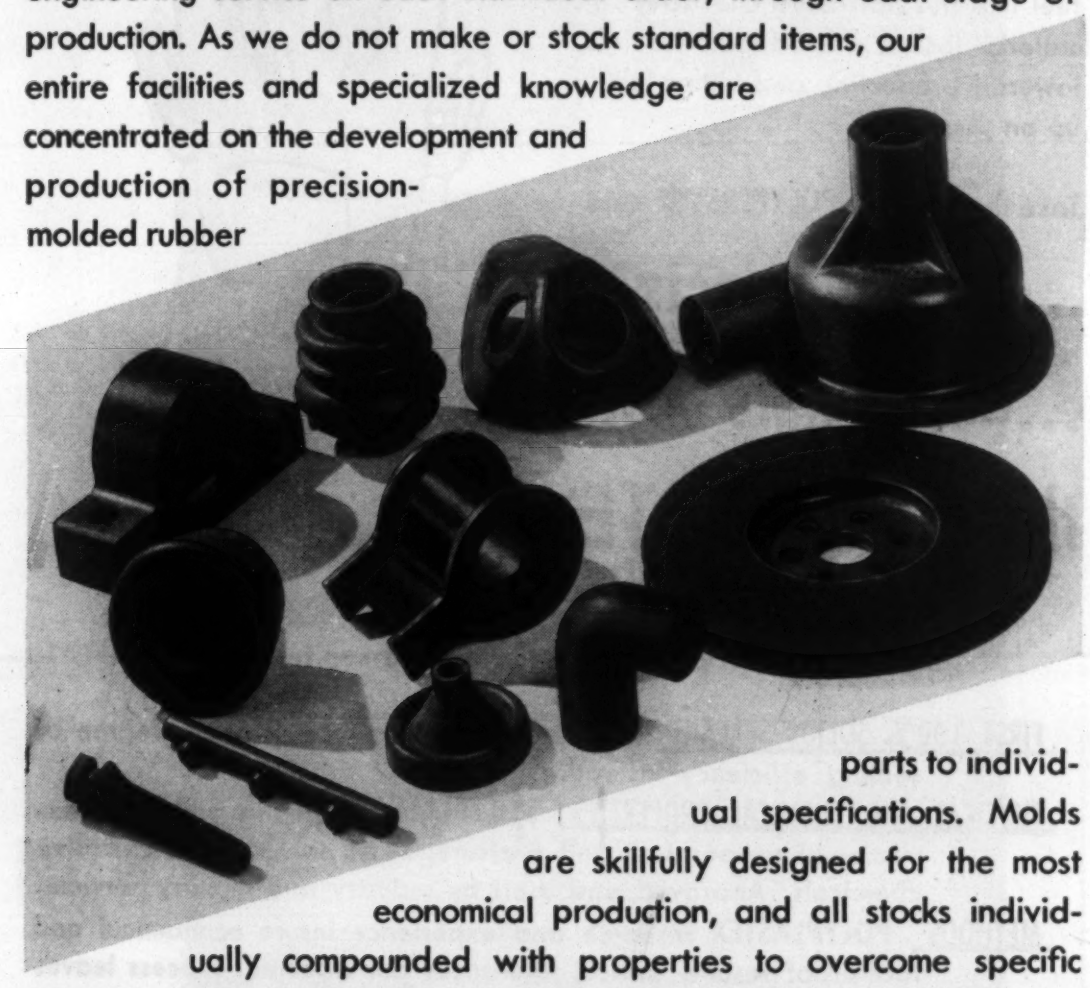
ADDRESS _____

CITY _____ STATE _____



Individualized RUBBER ENGINEERING

Here at ACUSHNET we are completely staffed to give individual engineering service on each individual order, through each stage of production. As we do not make or stock standard items, our entire facilities and specialized knowledge are concentrated on the development and production of precision-molded rubber



parts to individual specifications. Molds are skillfully designed for the most economical production, and all stocks individually compounded with properties to overcome specific conditions. When "precision" in rubber molded parts is a "must", you can depend completely on our engineering ability to meet your strictest requirements.

Send for your copy of the "Acushnet Rubber Handbook", a comprehensive rubber data reference for molded rubber parts.

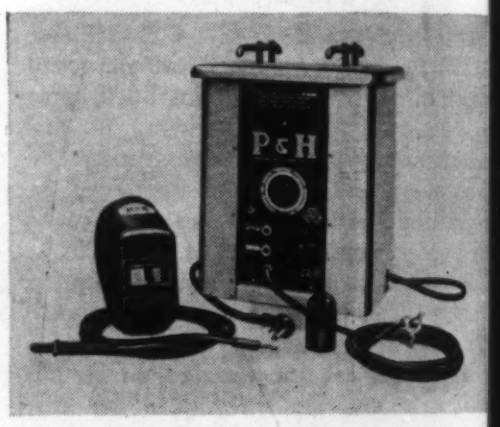
Acushnet
PROCESS COMPANY

Address all communications to 750 Belleville Ave., New Bedford, Mass.

New Materials and Equipment

new paint is said to prevent rust and to be resistant to corrosion from mild acids, alkalies, and industrial fumes. Upon heating, it is claimed to fuse with the surface of the metal on which it is applied, forming a solid copper coating which contracts and expands with temperature changes.

Developed especially for use on high pressure boilers, the paint is also recommended for ovens, exhaust manifolds, heat lines, compressors, engine heads, radiators, etc.



Small Shop Welder Now Available

Harnischfeger Corp., 4400 W. National Ave., Milwaukee 14, has introduced a new limited type input welder designed to save time and money. The new model, with a high open circuit voltage of 65 v, is said to have a welding range of 20 to 180 amp, making it ideal for welding thin fender metal on up to repair-welding of such heavy steel as tractor hitches.

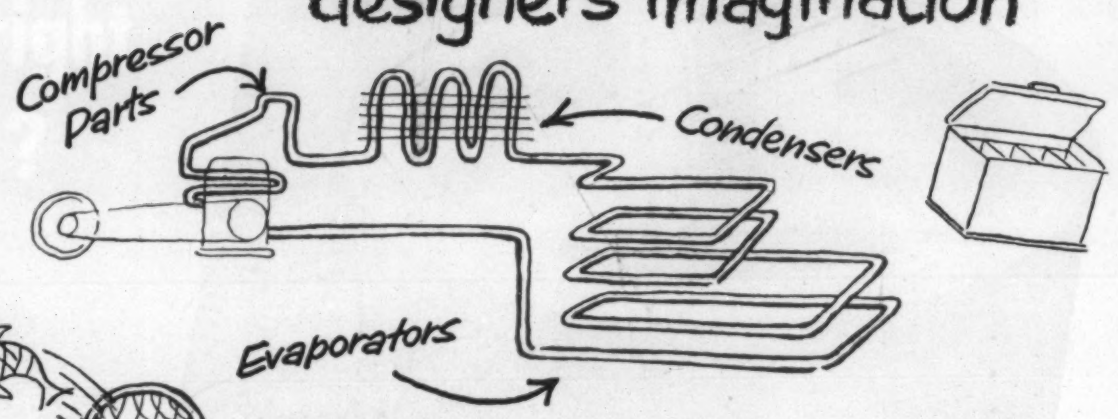
Company engineers say this new model is the only limited input type welder with Dial-Lectric control. Just a three-quarter turn of the Dial-Letcric knob provides continuous heat control from minimum to maximum capacity. The machine has both high range, for general purpose welding and low range, for light gage welding. Tests show the welder uses about 1 kw-h of electricity per hr of operation.

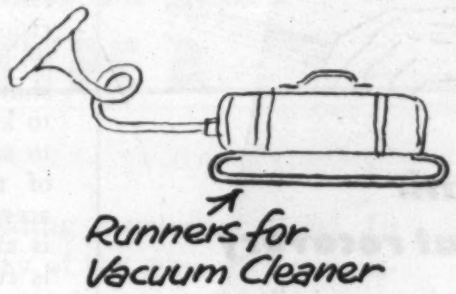
The welder comes fully equipped with all accessories, including cords, cables, welding helmet with protective lens, welding electrodes.

(*More News on page 188*)

Bundyweld "Doodles"

to jog a designer's imagination

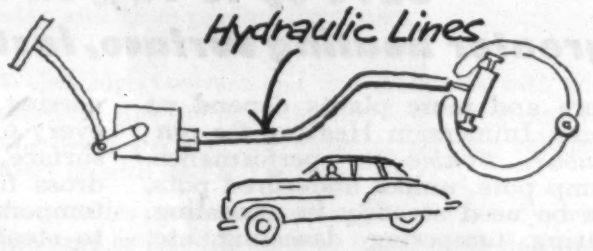




Working out a new part design? Then why not let Bundyweld Tubing and Bundy engineering skills help you get better-functioning parts, faster fabrication, lowered costs?

Bundyweld performance qualities make it practical for a wide choice of applications. And, with their tested experience in designing and fabricating tubing parts, Bundy engineers can often point out ways to save you time, material, money. Write for a catalog today.

Bundy Tubing Company, Detroit 14, Michigan



Bundyweld® Tubing

DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting point
High endurance limit
Extra-strong
Shock-resistant
Ductile
Lightweight
Machines easily
Takes plastic coating
Scale-free
Bright and clean
No inside bead
Uniform I.D., O.D.

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

←

NOTE the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: ***Cambridge, 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave. South ***Toronto, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

Kemp Immersion Melting Pots won't CRACK or BREAK

Save up to 40% on fuel with greater heating surface, faster heat recovery

More and more plants depend on Kemp Immersion Heating for *continuous, trouble-free* performance. Kemp pots, unlike underfired pots, can be used steadily in annealing, coating, tempering, descaling, etc. ... without the threat of *periodic* and *expensive* shutdowns for breakage. And each new Kemp installation means you eliminate costly temperature override, dangerous open flame fire hazards and the clutter of unsightly external pipes and ducts.

EFFICIENCY WITH ECONOMY

With Kemp Immersion Heating, you are assured maximum melting or heating efficiency... *plus* an estimated savings in fuel of up to *40% and more*. Thanks to Kemp engineering, these savings are built into every unit. You get greater heating surface, faster heat recovery, lower dross formation, even lower room temperatures. There's no brickwork to steal heat ... no external combustion chamber ... no carbon monoxide. You're money ahead when you switch to Kemp.

EASY TO USE, EASY TO MAINTAIN

The Kemp Carburetor, part of each installation, delivers complete combustion ... without waste ... without tinkering. One-pipe air and fuel feed reduces installation costs, simplifies maintenance. Kemp service also includes a staff of trained technicians who are instantly available at all times.

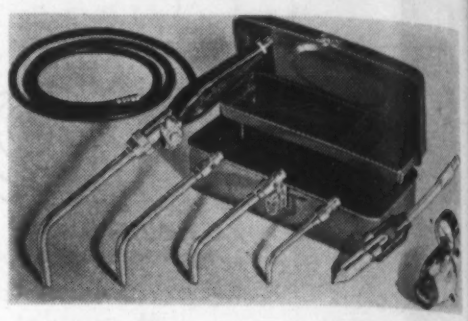
KEMP *IMMERSION MELTING POTS*
OF BALTIMORE

for technical information and facts on how we can help you cut your melting costs, write:

THE C. M. KEMP MFG. CO.
405 E. Oliver St., Baltimore 2, Md.

CARBURETORS • BURNERS • FIRE CHECKS • ATMOSPHERE & INERT GAS GENERATORS
ADSORPTIVE DRYERS • METAL MELTING UNITS • SINGEING EQUIPMENT • SPECIAL EQUIPMENT

New Materials and Equipment



Air Acetylene Outfit for Soldering, Heating, Light Brazing

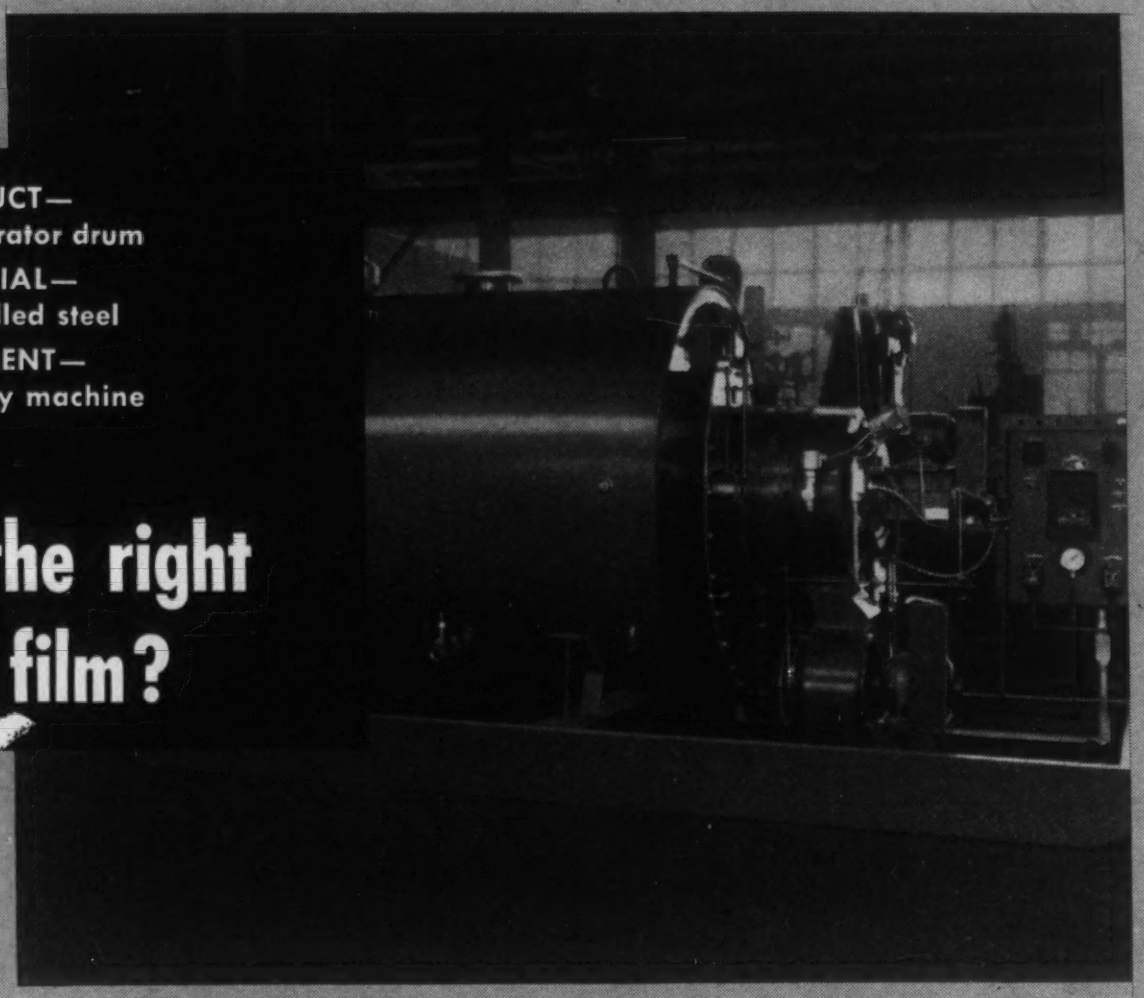
Full capacities of five separate outfits for soldering, heating and light brazing are now combined in one new Presto-O-Lite 5-in-1 Precision Outfit produced by *Linde Air Products Co.*, a division of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17. According to the company, all work, from very fine soldering in radio and television sets to work requiring a large volume of heat, such as thawing frozen pipes and light brazing, can be handled by the unit.

Four open-flame torch stems and a pointed copper soldering iron attach interchangeably to a newly designed precision control handle which is equipped with a pilot needle valve contained in the shutoff valve. This valve can be adjusted to keep only a small pilot flame burning, to save gas on intermittent work. A flip of the thumb operates the valve. The acetylene pressure regulator in this outfit is also said to be of the latest design. It is fully adjustable to deliver acetylene at any pressure up to 13 psi as long as usable pressure remains in the tank. No adjustment is needed on the cylinder valve to compensate for decreasing cylinder pressure.

A 4-in-1 outfit also is being produced in the new line of apparatus. This smaller outfit covers the same range of work with the same parts as the larger combination, but does not include a soldering iron for working in locations where an open flame would not be practical.

Aluminum Paint Can Be Applied Over Rust

Addition of a new aluminum anti-rust paint to the company line has been announced by *Paint Corp. of America*, Fidelity Bldg., Cleveland 14. Known as



PRODUCT—
Steam generator drum
MATERIAL—
13/32" rolled steel
EQUIPMENT—
250 kv x-ray machine

What's the right x-ray film?

KODAK INDUSTRIAL X-RAY FILM, TYPE A

MUCH IS GAINED by welding a pressure vessel. In this case dependability of the generator was increased, while weight was reduced 15% and costs dropped 10% to 20%. But each weld must be proved sound radiographically.

To make the radiographs, the radiographer used 145 kv, and Kodak Industrial X-ray Film, Type A, with .005-inch front-and-back lead screens.

Type A has high contrast and fine graininess, and sufficient speed to take full advantage of high kilovoltage machines in radiographing thick or dense materials. It also is first choice for the examination of light alloys with short exposures at low voltage.

A TYPE OF FILM FOR EVERY PROBLEM

To provide the recording medium best suited to any combination of radiographic factors, Kodak produces four types of industrial x-ray film. These provide the means to check welds and castings efficiently and thus extend their use.

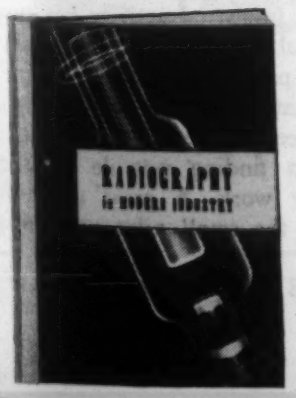
Type A—has high contrast and fine graininess with adequate speed for study of light alloys at low voltage and for examining heavy parts at intermediate and high voltages. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, with direct exposure or lead-foil screens. It has extra-fine grain and, though speed is less than Type A, it is adequate for light alloys at average kilovoltages and for much million- and multi-million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays when exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage, without use of calcium tungstate screens.

Radiography . . . another important function of photography



RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get a copy from your local x-ray dealer—price, $3.

EASTMAN KODAK COMPANY
X-ray Division • Rochester 4, N. Y.

Kodak
TRADE-MARK

The Haller
OIL WELL PRINCIPLE

Now Being Applied To
POWDERED METAL PARTS LIKE THESE

Various types of bearings, bushings, gears, wear plates, machine gibs and other powdered metal parts now incorporate the Haller Oil Well feature.

Originally introduced in bearings, the forming of cavities or "pockets" in the center of powdered metal parts has proved to be a highly successful method of increasing oil content. In such parts, as oil or grease is impregnated into the sintered metal by static pressure, it fills the cavities as well as the pores in the sintered metal body itself. The result is a greatly increased lubricating quality which permits the parts to take heavier loads in their particular applications.

With the many new possibilities for adaptation of this design principle to a wide variety of parts, it can be to your advantage to investigate how it can be applied to your present or future products. The one limiting factor to be considered at the present time is that "oil well" parts are being produced in high volume on a contract basis only. We invite your inquiries.

Write for this bulletin describing our facilities and the scope of our powdered metal parts production.

MICHIGAN POWDERED METAL PRODUCTS COMPANY, INC.

476 CADY STREET • NORTHVILLE, MICH.

Subsidiary of

ALLIED PRODUCTS CORPORATION

New Materials and Equipment

PCA-102 Aluminum, the new paint is made of doubly pigmented aluminum mixed with a clear base vehicle. The latter is identical to PCA 101, which the company has sold for many years as a clear rust inhibitive.

Because of its use of the clear anti-rust base, the new paint can be applied easily and quickly without any possibilty of the base bleeding through. According to the company, the clear base also lends a 10% brighter appearance than ordinary aluminum paints. It permits better leafing of the aluminum flakes to form a moisture-proof coating.

PCA102 can be applied by brush or spray right over rust without priming, scraping, wire brushing or sandblasting. It is said to penetrate rust layers and to seal the base metal against further rust action. It is equally effective as a rust preventive when applied over any kind of new metal surface.

Plating Units for Pilot and Laboratory Use

Hollywood Bronze Supply, 1624 E. 1st St., Los Angeles 33, is now manufacturing a complete line of plating units designed specifically for pilot plant and laboratory use. The company has been manufacturing electroplating equipment for the past 10 years, catering mostly to the jewelry manufacturing and large electroplating laboratory needs.

Increased industrial activity has created an abnormal demand for electroplating component parts in practically every industrial plant in the country, and processing engnieers have been experiencing difficulty in finding outside contractors to do their work. A great many firms are finding the small pilot plant operat-

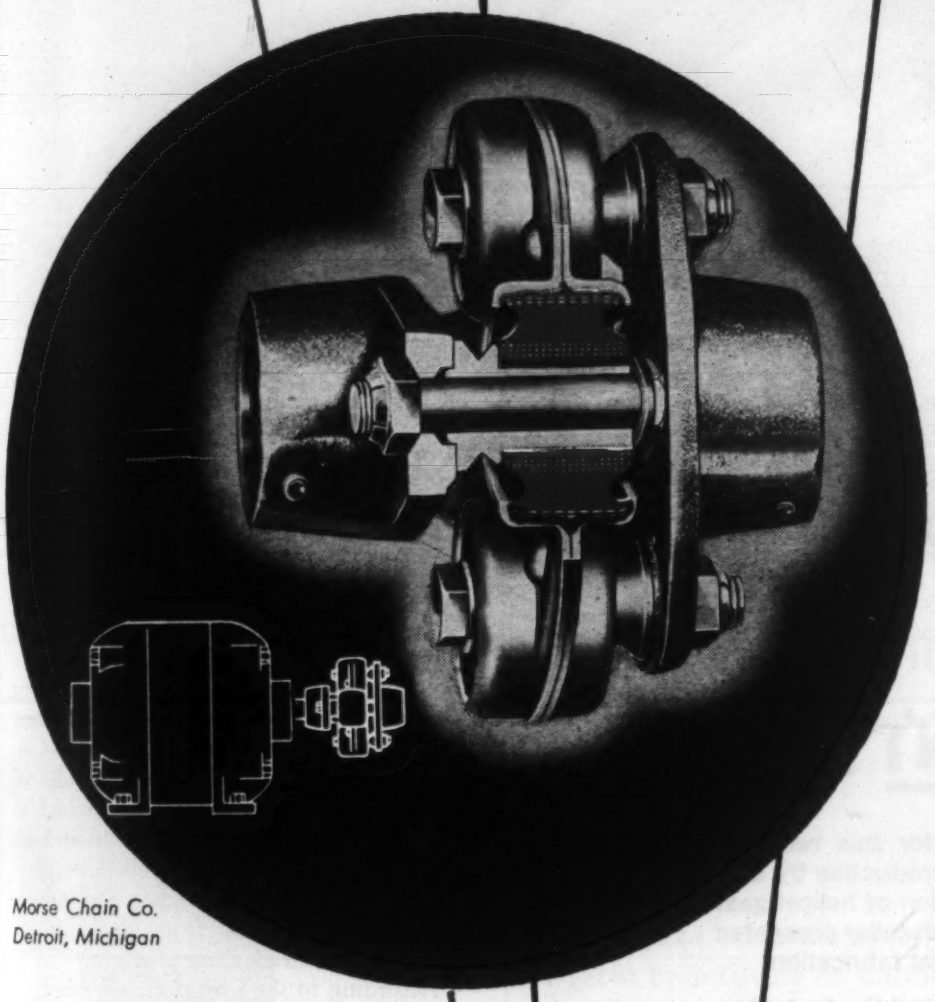
FLEXIBILITY

OIL RESISTANCE

LOW COMPRESSION SET

These properties of neoprene make a better

FLEXIBLE COUPLING

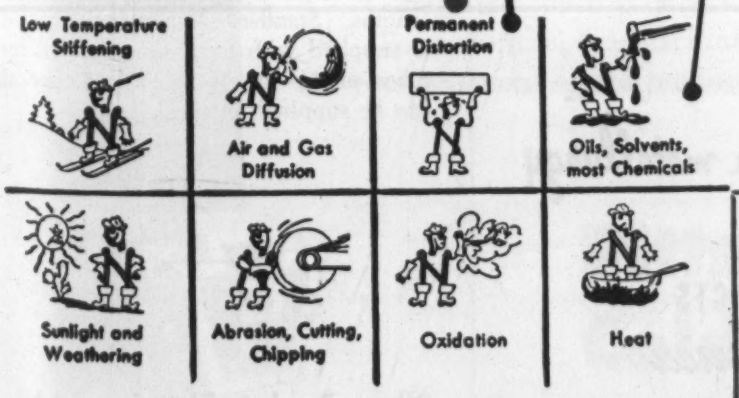


Morse Chain Co.
Detroit, Michigan

Power is smoothly transmitted between two shafts by this improved coupling, even under conditions of extreme misalignment. Four neoprene "biscuits," designed for uniform stress and deflection, compensate for difference in shaft positions . . . provide exceptional flexibility without creating undue thrust loads on bearings. At the same time, the resilient neoprene "biscuits" isolate vibration and absorb shock loads—resulting in a quiet-running assembly with a long service life.

Neoprene was selected for this important role because of its low compression set, an essential property for good vibration dampening characteristics. And neoprene's oil resistance and excellent flexing properties mean long life despite constant exposure to rugged service conditions. Such performance is duplicated in thousands of other products where neoprene's outstanding properties have contributed to improvements in product design.

PROPERLY COMPOUNDED NEOPRENE WILL RESIST:



Send for the "Neoprene Notebook." Each issue shows new, unusual applications of neoprene . . . new products . . . improved designs. Use the handy Reader Service card or write us directly. We'll add your name to our mailing list . . . and send information on other uses of neoprene and sources of supply, if you desire. E. I. du Pont de Nemours & Co. (Inc.), Rubber Chemicals Division A-10, Wilmington 98, Delaware.

DU PONT

150th Anniversary

Better Things for Better Living
...through Chemistry

NEOPRENE

The rubber made by Du Pont since 1932

POWDERMET SUCCESS STORY NO. 12

THE GEAR THAT COULDN'T BE MADE!

Designers specified powdered metal for this two inch helical gear to avoid the high cost of production by conventional methods. But the combination of helical gear teeth with the axial elements of the clutch collar presented an unusual problem in powdered metal fabrication.

That's why they came to Powdered Metal Products Corporation of America . . . the gears, made from a special bearing bronze in production quantities, cost less than fifty cents each!

Write today for complete information on the possibilities of POWDERMET* Gears, both standard and special.

sign of leadership PMP in powder metallurgy

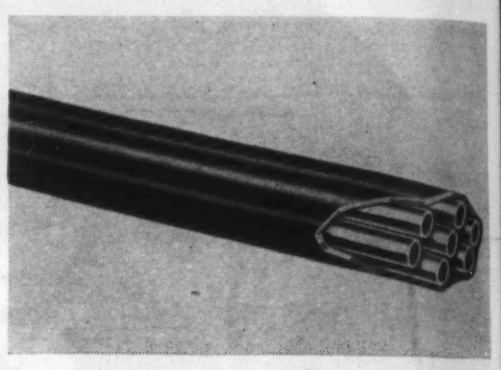
POWDERED METAL PRODUCTS CORPORATION of America

9335 West Belmont Avenue,
Franklin Park, Illinois

*Trademark

New Materials and Equipment

ing units a solution to their electroplating problems. The company also manufactures larger sized electroplating equipment according to specifications.



Polyethylene Corrosion Resistant Tubing Harness

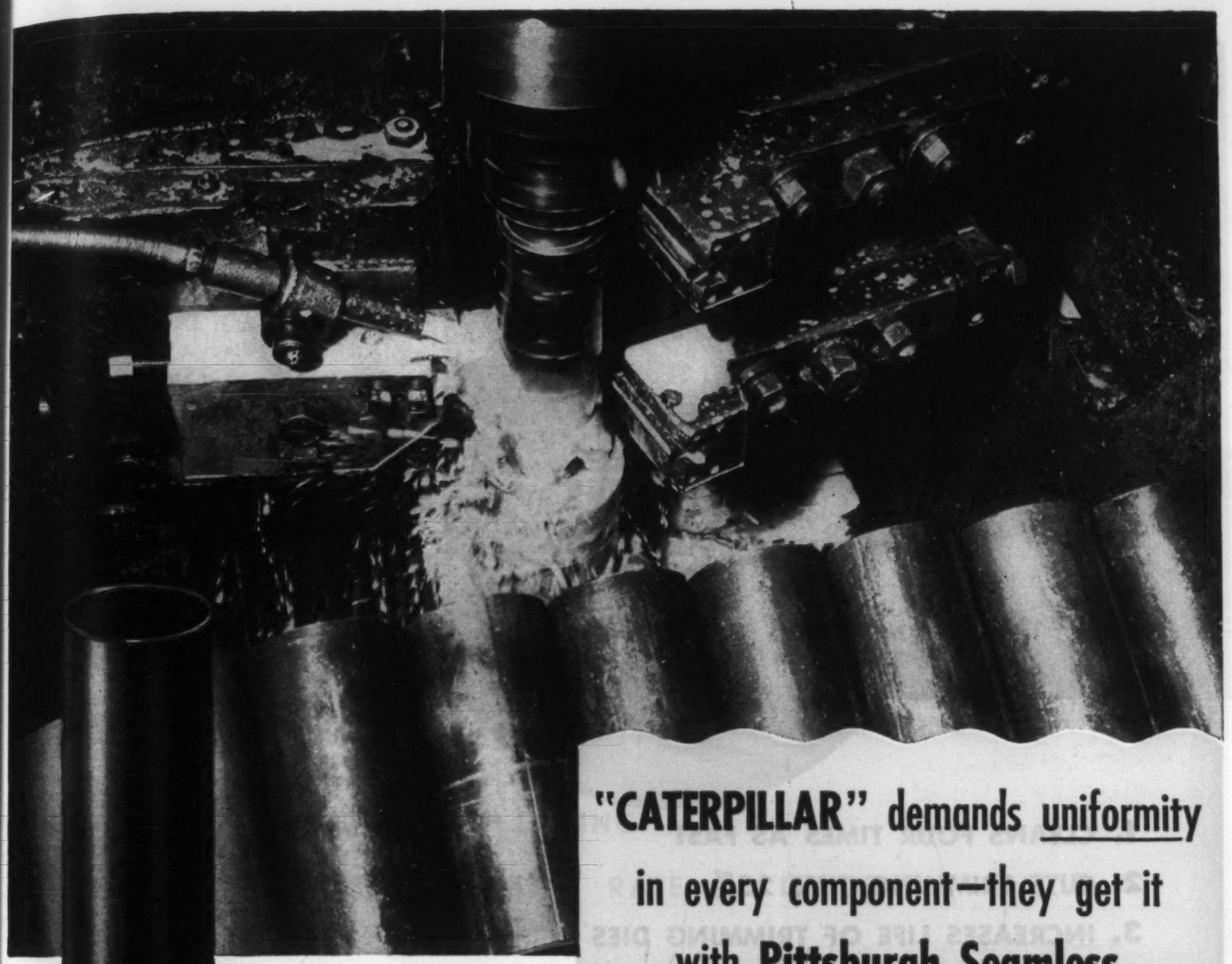
A new type corrosion-proof instrument tubing harness, for which patents have been applied, has been announced by *Samuel Moore & Co.*, Mantua, Ohio. Known as Dekoron Impervapak Metl-Cor, the harness is composed of a bundle of copper or aluminum tubes over which is extruded a 1/16-in. thick sheath of high molecular weight black polyethylene plastic. This construction renders the tubing impervious to attack from moisture or corrosive industrial atmospheres.

According to the manufacturer, the harness has lower initial cost than corrosion resistant alloy tubing, costs less to install than individual instrument lines, and conserves critical material.

The new product is available in lengths up to 50 ft. A standard line of pressure-tight fittings is used to join successive lengths. Standard Impervapak Metl-Cor is supplied with four, seven or ten metal tubes of ¼- or ⅜-in. o.d. Other sizes can be supplied on special order.

Silver Brazing Flux for 1145 to 1300 F Range

A new flux, known as G-B No. 99, is currently being offered by *Goldsmith Brothers Smelting & Refining Co.*, 1304



"CATERPILLAR" demands uniformity in every component—they get it with Pittsburgh Seamless Cold-Drawn Tubing

The uniformly excellent performance of "Caterpillar" built products is no mere chance. They get it by insisting on uniformity in every component of their equipment. For example, thousands of the track pin bushings shown being machined above are made of Pittsburgh Seamless Cold Drawn Tubing. It has the necessary size accuracy and finish to facilitate machining—the uniform physical properties that make big, high-speed production runs possible. The result is that the parts made from Pittsburgh Seamless have the consistent high quality found in all "Caterpillar" built products.

For a uniform, free machining cold-drawn mechanical tubing that helps improve your products—speed production, specify Pittsburgh Seamless.

Pittsburgh Seamless Cold Drawn Tubing

a product of **Pittsburgh Steel Company**

Grant Building, Pittsburgh 30, Pa.

at HAUN DROP FORGE CO., LTD., Welland, Ontario

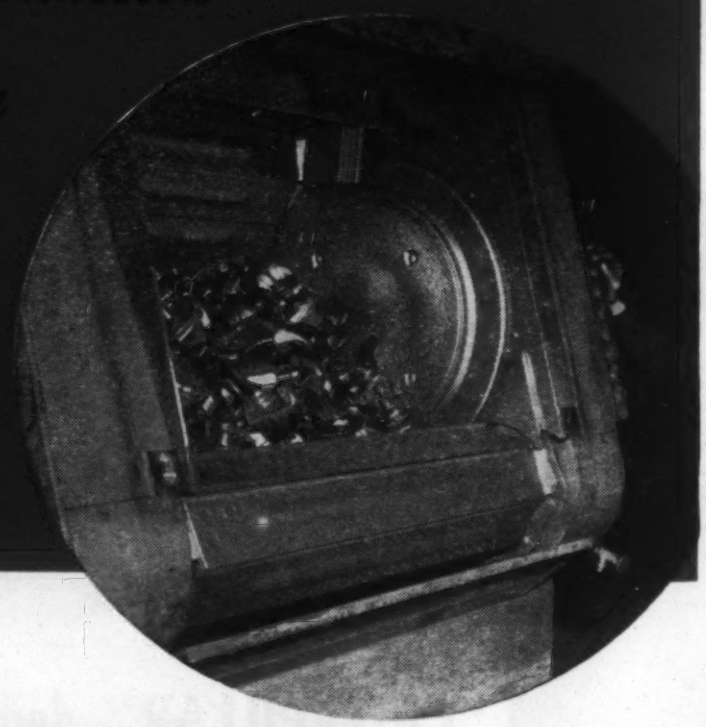
WHEELABRATOR®

increases production

efficiency

4

ways



1. CLEANS FOUR TIMES AS FAST
2. CUTS TRIMMING TIME 25%
3. INCREASES LIFE OF TRIMMING DIES
4. SPEEDS PIERCING OPERATIONS 35%

At Haun Drop Forge Co., Ltd. installation of a Wheelabrator Tumblast replaced a number of tumbling mills for cleaning drop forgings. Because Wheelabrating is so much faster cleaning time was slashed 75%. It also provides a better-cleaned surface and improved finish which speeded up all operations which follow cleaning.

Trimming time is reduced 25% and piercing operations simplified due to the thorough removal of all scale. Whereas it had been necessary to clean the pressure plate used in trimming thin section forgings — requiring 30 minutes time every two hours — this costly time-consuming task has been eliminated.

Let Wheelabrator engineers show you how to conserve manpower and reduce costs in your cleaning and finishing department. There's no obligation, of course. Send today for details.

American

WHEELABRATOR & EQUIPMENT CORP.
838 S. Byrkit Street, Mishawaka 5, Indiana
WORLD'S LARGEST BUILDERS OF AIRLESS BLAST EQUIPMENT

New Materials and Equipment

W. 59th St., Chicago 36. Compounded by a special process which provides complete stabilization, the new flux is said to achieve the following characteristics:

1. Exceptional ability to climb and spread over the entire joint area, providing maximum fluxing action during brazing.
2. Ideal for torch application where heating cycles are short.
3. Quickly and thoroughly dissolves metallic oxides, permitting a uniform flow of silver solder to produce strong, sound joints.
4. Fully active through a low temperature range of 800 to 1350 F. Recommended for use with silver solder having a melting range of 1145 to 1300 F.

G-B No. 99 is completely dehydrated and is packaged as a dry flux. Water is added to the dry flux to make a creamy paste, and can be mixed in small batches as needed.

Fuel Mixer Changes Heating Loads Easily

Changing heating loads on combustion equipment is now simplified by a new Vari-Set Mixer offered to industry by *Eclipse Fuel Engineering Co.*, 1002 Buchanan St., Rockford, Ill. A built-in, adjustable orifice eliminates replaceable jets, and changes volume of automatically proportioned gas and air for any BTU output within the capacity of various sized mixers used in furnaces, ovens, kilns, and other combustion equipment.

Gas entrained by the air steam is automatically proportioned to form a mixture that gives perfect combustion at all heating loads. A metering valve regulates the pressure for operating control equipment and for burning mixed, natural or L.P. gas.

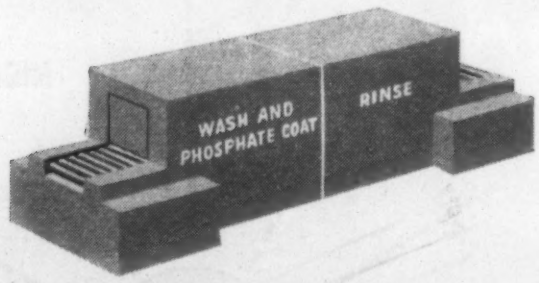
Advantages can be seen in many industries where heating equipment is operated in series or in parallel. In parallel hook-ups, equipment can be operated under varying loads with this one type of mixer, and any unit can be changed quickly and easily without dismantling pipes, burners, mixers and other equipment. Unproductive downtime is said to be eliminated. For units that are operating in a series, the

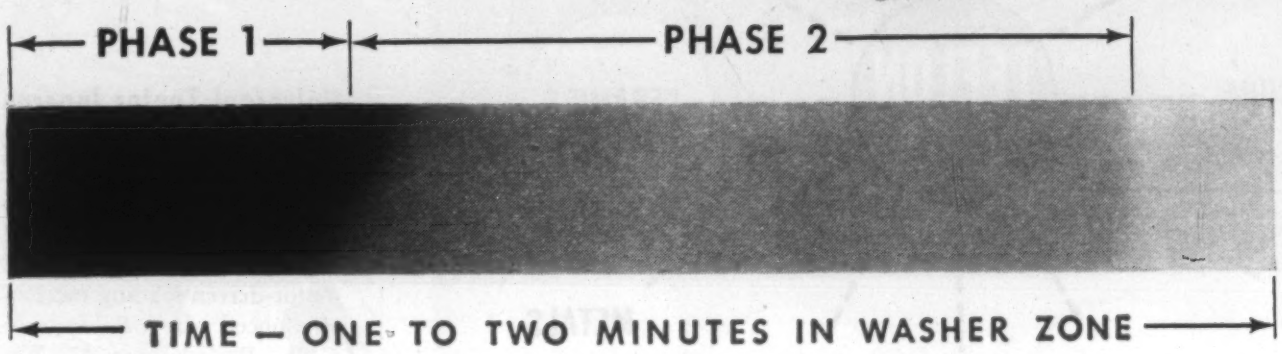
DETREX

METAL CLEANERS

Visit us . . .

at the National Metals Exposition, Philadelphia, October 20-24. We'll be in Booth 1849.





PHASE 1 — CLEANING

PHASE 2 — RAPID RATE OF DEPOSIT

DETREX 79 cleans and phosphate coats in one operation . . .

Detrex 79 is a dual-purpose compound that both cleans and phosphate coats.

Used in a spray washer, "79" produces a fine-textured, highly adherent phosphate coating on steel and cast iron parts. This coating provides a rust-resisting surface that gives excellent adhesion for paint finishes.

Detrex "79" is economical to use and requires no special equipment. Cleaning *and* phosphate coating of ferrous metals is done in a single stage of any standard two- or three-stage washer. Work comes out of the washer clean and with a phosphate-coated surface that dries to a uniform gray mat finish.

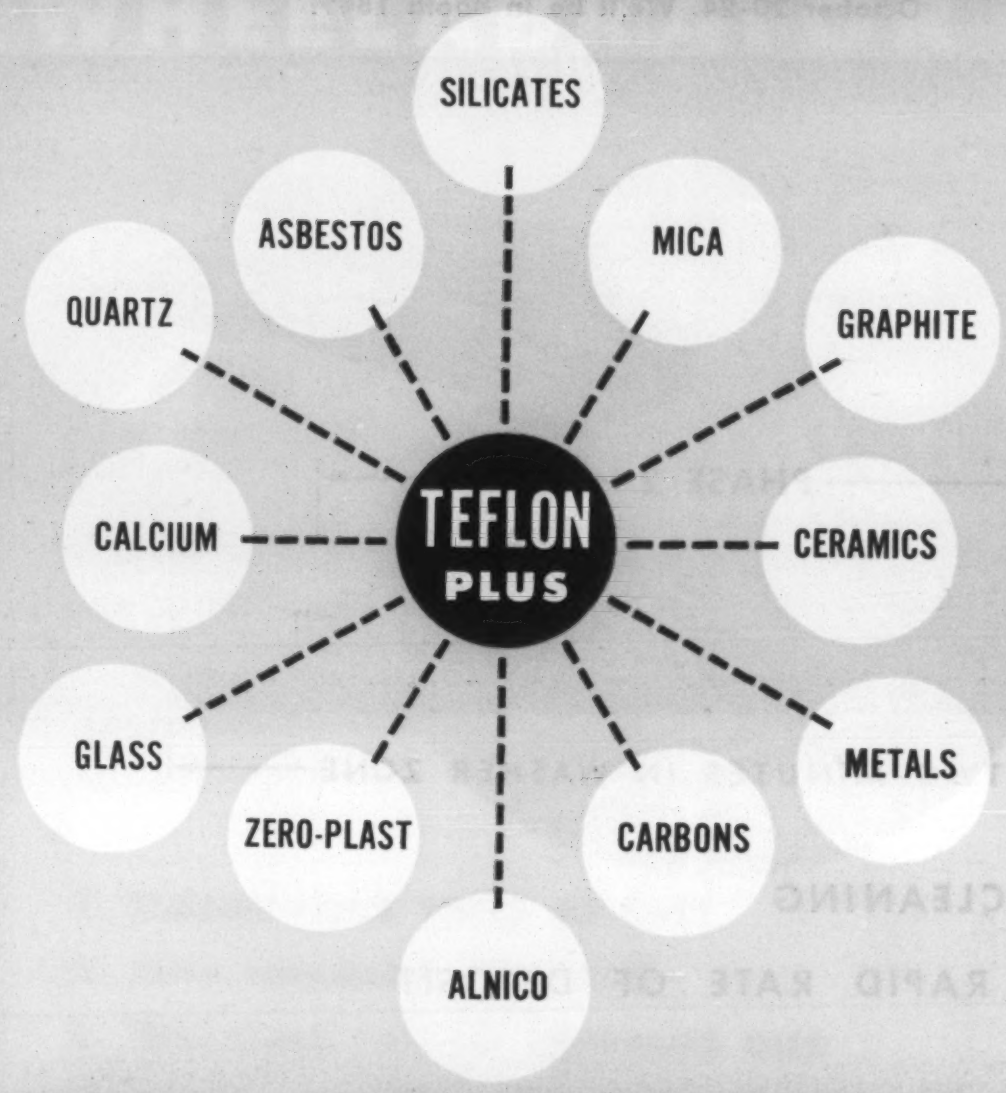
A trained Detrex field engineer can show you the advantages of 79 and other Detrex phosphate coatings in your plant. If a new operation is being considered, he can also give you recommendations on equipment . . . for, you see, Detrex offers you the "one-source" advantage of cleaning compounds *and* processing equipment.

For complete information or free consultation service, write to **Detrex Corporation, Box 501, Detroit 32, Michigan.** A-3

DETREX CORPORATION

DEGREASERS • DEGREASING SOLVENTS • WASHERS
ALKALI & EMULSION CLEANERS • DRYCLEANING EQUIPMENT
PHOSPHATE COATING PROCESSES

ENGINEERED FLUOROCARBONS



Offer Engineers a Whole New Family of Materials

Starting with TEFLON*, United States Gasket Company engineers have developed a series of "Filled" Fluorocarbon materials, greatly broadening the scope of usefulness of this wonder-plastic. For example, United States Gasket Company "Application Engineering" has already helped solve such material problems as long-wearing chemical resistant bearings and pump impellers; valve and pump packings, expansion joints and chambers, gaskets; the metal plating of Teflon; the hermetic sealing of electronic components; soldering and cementing to Teflon; etc., etc.

If you have a special materials problem, that one of these Teflon "alloys" might solve, tell us about it. Our engineering department will work with yours to determine the Chemelec Mixture best suited to your requirements.

UNITED STATES GASKET COMPANY

FLUOROCARBON PRODUCTS DIVISION

FABRICATORS OF "TEFLON" "KEL-F" AND OTHER FLUOROCARBON PLASTICS

CAMDEN 1, NEW JERSEY

*duPont's trademark for its tetrafluoroethylene resin.

New Materials and Equipment

individual burners can be adjusted without changing the output of the other units.

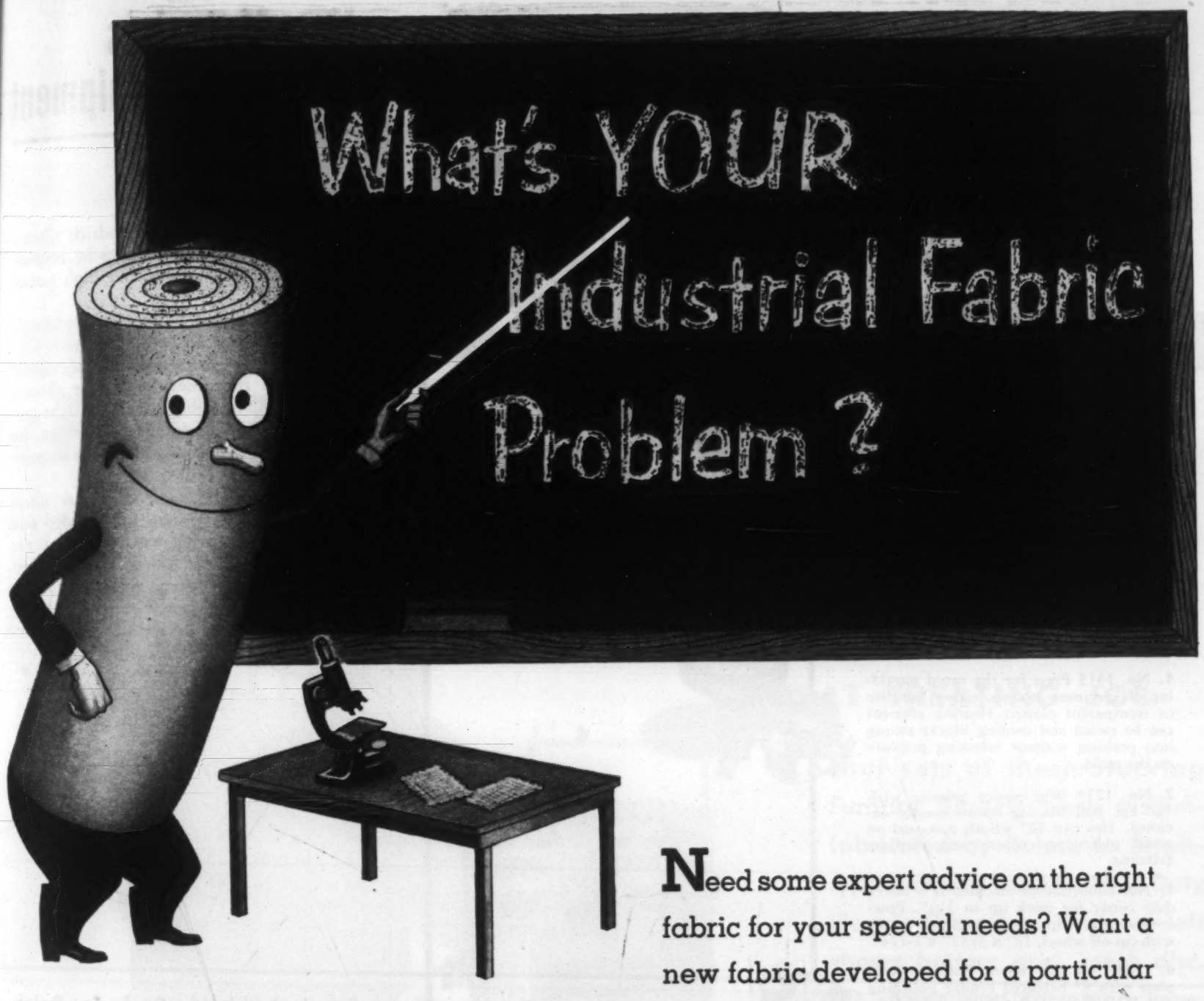
Universal Tester Incorporates Many New Features

A totally new type of universal testing machine, incorporating an electric weighing system and electronically-controlled, motor-driven loading mechanism, has been announced by *Baldwin-Lima-Hamilton Corp.*, Philadelphia 42. The new Model FGT Baldwin-Emery SR-4 testing machine has a capacity of a 50,000-lb load and is said to offer the following advantages:

1. Accuracy and sensitivity corresponding to that of the best scales, weighing and measuring tolerances of 0.2% of reading.
2. High-speed response of indicator or recorder to dynamic as well as static loads.
3. Extreme structural stiffness and lateral rigidity.
4. Wide range of loading speeds under precise stepless control. (Standard loading speed is 0.025 to 9.0 ipm.)
5. Automatic load control for maintaining (1) constant load, (2) constant strain, (3) constant rate of loading, or (4) constant strain rate—thus enabling determination of creep, rupture, and relaxation properties of materials.
6. Quick-acting, semi-automatic operation for production testing and adaptability to stress analysis of parts and components of structures on which SR-4 strain gages or brittle coating techniques are utilized.

Oil Resistant Rubber Seals Prevent Leakage

Special oil resistant rubber seals have been developed to prevent dangerous oil leakage from aircraft propeller oil control assemblies by *National Motor Bearing Co., Inc.*, Redwood City, Calif., and *Hamilton-Standard Aircraft.* Made from Hycar rub-



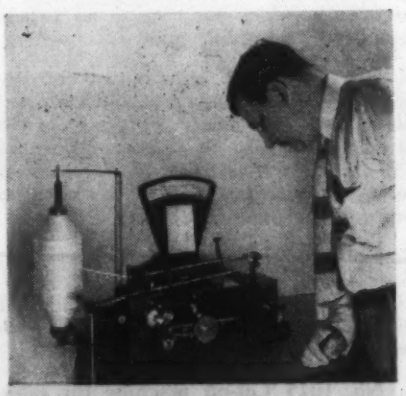
Need some expert advice on the right fabric for your special needs? Want a new fabric developed for a particular purpose—or an existing fabric adapted to a new application? We believe you'll find Mt. Vernon-Woodberry has the skill and experience it takes to work it out. Can we help?

STANDARD FABRICS

Wide, Sail and Army Duck
Double and Single Filling
Hose-Belting and Shoe Duck
Filter Cloths
Dryer Felts
Narrow and Wide Drills
Twills

AT YOUR SERVICE

Mt. Vernon-Woodberry Mills' staff of textile engineers is available on request to help you with your problems in development or application of industrial fabrics.



Shown is one of a series of comprehensive laboratory controls throughout production to assure uniformity in all Mt. Vernon-Woodberry products. Here coefficient of variation and average factor of quality on evenness in roving is being checked with Belger Tester.

FABRICS BUILT TO SPECIFICATIONS

For Calendering, Laminating and Other Industrial Applications

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TURNER HALSEY
COMPANY
Selling Agents
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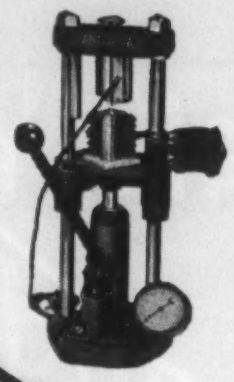
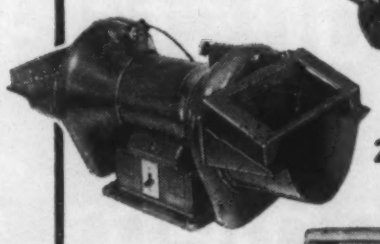
Buehler

Offers a Complete Line of Equipment for the . . . METALLURGICAL LABORATORY

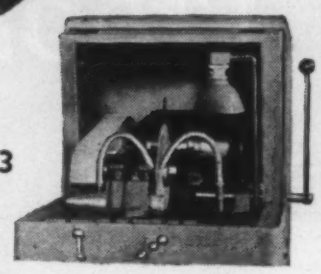
Buehler specimen preparation equipment is designed especially for the metallurgist, and is built with a high degree of precision and accuracy for the fast production of the finest quality of metallurgical specimens.



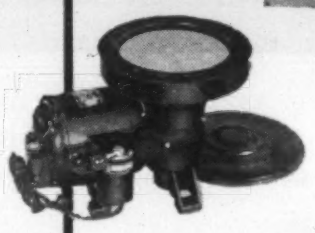
1. No. 1315 Press for the rapid moulding of specimen mounts, either bakelite or transparent plastic. Heating element can be raised and cooling blocks swung into position without releasing pressure on the mold.



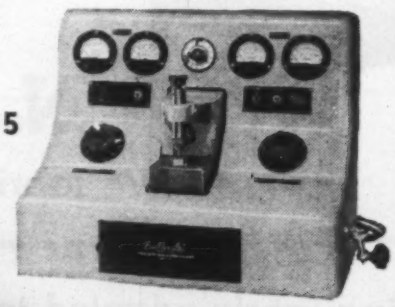
2. No. 1211 Wet power grinder with ¾" hp. ball bearing motor totally enclosed. Has two 12" wheels mounted on metal plates for coarse and medium grinding.



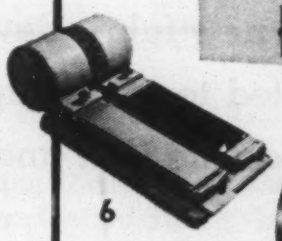
3. No. 1000 Cut-off machine is a heavy duty cutter for stock up to 3½". Powered with a 3 hp. totally enclosed motor with cut-off wheel, 12" x 3/32" x 1-1/4".



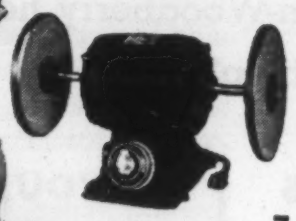
4. 1505-2AB Low Speed Polisher complete with 8" balanced bronze polishing disc. Mounted to ¼ hp. ball bearing, two speed motor, with right angle gear reduction for 161 and 246 R.P.M. spindle speeds.



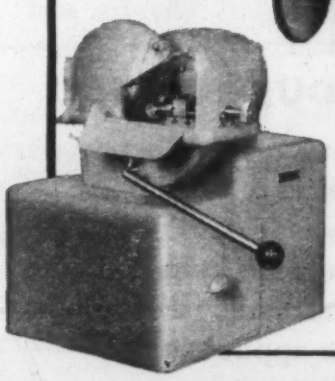
5. No. 1700 New Buehler-Waisman Electro Polisher produces scratch-free specimens in a fraction of the time usually required for polishing. Speed with dependable results is obtained with both ferrous and non-ferrous samples. Simple to operate—does not require an expert technician to produce good specimens.



6. No 1410 Hand Grinder conveniently arranged for two stage grinding with medium and fine emery paper on twin grinding surfaces. A reserve supply of 150 ft. of abrasive paper is contained in rolls and can be quickly drawn into position for use.

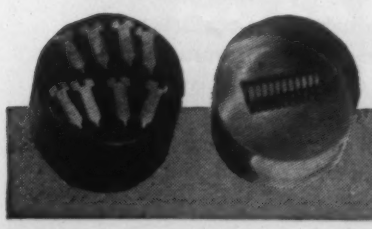


7. No. 1400 Emery paper disc grinder. Four grades of abrasive paper are provided for grinding on the four sides of discs, 8" in diameter. Motor 1/3 hp. with two speeds, 575 and 1150 R.P.M.



8. No. 1015 Cut-off machine for table mounting with separate unit recirculating cooling system No. 1016. Motor 1 hp. with capacity for cutting 1" stock.

The Buehler Line of Specimen Preparation Equipment includes . . . Cut-off Machines • Specimen Mount Presses • Power Grinders • Emery Paper Grinders • Hand Grinders • Belt Surfacers • Mechanical and Electro Polishers • Polishing Cloths • Polishing Abrasives.



Buehler Ltd.

A PARTNERSHIP

METALLURGICAL APPARATUS

165 WEST WACKER DRIVE, CHICAGO 1, ILLINOIS

New Materials and Equipment

ber, a product of B. F. Goodrich Chemical Co., the seals are said to be resistant to extreme temperatures and high surface speeds.

The assembly of a propeller integral oil control must operate in temperatures varying from —65 to 220 F. Surface speeds reach 3250 fpm, meaning severe abrasive conditions. The rubber seals must be precision-molded and compact in design due to critical space and installation requirements.

The two seals made of Hycar nitrile rubber are each 6½ in. i.d. molded onto a metal base, spring-tensioned, and precision-trimmed. A specially designed sealing lip increases flex action. The sealing members must be usable with AN-0-8, Grade 1100 and AN-0-9 Grade 1010 fluids, and MIL-0-5606 oil.

Polyvinyl Chloride Resin for Calendering, Extruding and Molding

Introduction of the first in a new series of Pliovic polyvinyl chloride resins has been announced by the Chemical Div., *Goodyear Tire & Rubber Co.*, Akron 16, Ohio. Designated Pliovic G90V, the new resin has been described as a general purpose, straight vinyl material having an approximate intrinsic viscosity of 0.90.

Outstanding thermal stability of the resin is the basis for its recommendation for universal use in calendering, extruding, injection molding and conventional molding of vinyl materials. Both clear and pigmented products are said to benefit from the excellent light stability and good color of the resin. Other merits include a high bulk density for ease of handling and easy interchangeability with other resins.

According to the company, the new product is expected to find its most extensive applications in calendering of both vinyl film and sheeting for rainwear, draperies, upholstery and similar materials.

Both plant and laboratory tests have demonstrated that products made with the resin exhibit low water absorption, relatively good flexibility at low temperatures, and other desirable physical characteristics. Clarity of unpigmented compounds is reportedly exceptional.

ROLOCK

HEAT AND CORROSION RESISTANT

FABRICATED ALLOYS

AN ASSEMBLY THAT *"Gives a Lift"* TO AN IMPORTANT HEAT TREATING JOB

Four sets of these Stacking Furnace Baskets were custom-fabricated by Rolock to fit pit-type furnaces built by Hevi Duty Electric Company. Photo at left shows bottom grid, mesh disc, lift straps and fastening keys. Photo at right shows complete assembly ready for furnace.

They are used by a nationally known manufacturer for hardening at 1850° F. Material of basket is type 330 stainless steel. Size, each basket 28" I.D. x 12¾" high. To facilitate handling in and out of the furnace the baskets are securely fastened together with alloy lift straps and keys. Note fabricated bottom grid and mesh disc. All welding is of the highest quality.

Rolock equipment is engineered to suit the specific job... for maximum strength... for as high ratio of load to weight as safety permits ...for handling convenience... and for low hour-cost through extended service life. Our engineering department likes to solve problems. Tell us about yours!

Rolock Booth No. 1810—National Metal Exposition, October 20-24, 1952, Philadelphia, Pa.

Offices: PHILADELPHIA, CLEVELAND, DETROIT, HOUSTON, CHICAGO, ST. LOUIS, LOS ANGELES, MINNEAPOLIS, PITTSBURGH

ROLOCK INC. · 1282 KINGS HIGHWAY, FAIRFIELD, CONN.

JOB-ENGINEERED for better work Easier Operation, Lower Cost

WAREHOUSE STEEL USERS—

Our *Personalized Steel Service* gives you more value for your dollar

Check this list **of extra, money-saving benefits against what you are getting from your present warehouse steel source.**

- **14 warehouses** to draw on—We will conduct nation-wide search for your needs—no *extra* cost.
- **Technical assistance**—Our product experts will work "full-time" helping solve your material or production difficulties—no *extra* cost.
- **Complete** shearing, cutting and burning service—Our modern equipment enables you to get your steel cut quickly and accurately to your specifications—regular warehouse charges apply.
- **A "one-call" source** for all your steel needs—Carbon—Alloy—Stainless—Tubing—Aluminum—Machinery and shop supplies. We stock them all for you—no *extra* charge.
- **Personalized Service**—*All* of our people are trained to treat you right.

Your friendly U. S. Steel Supply salesman puts our service team to work for you. Why not let him help you?

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USS

UNITED STATES STEEL

New Materials and Equipment

Batch Furnace for Versatile High Production Heat Treating

A new batch furnace, said to be capable of case and homogeneous carburizing, dry cyaniding, clean hardening and carbon restoration at high production rates, is currently available from *Surface Combustion Corp.*, Toledo, Ohio. Available in two capacities—500 and 1600 lb per hr gross—the new All-case furnace embodies the versatility and economy of the standard type heat treat furnace with the high production rate inherent in specialized units.

The operating temperature range is 1450 to 1750 F, utilizing radiant tube heating elements and a forced convection recirculating fan. A special enclosed quench chamber permits rapid direct quench under controlled atmosphere conditions.

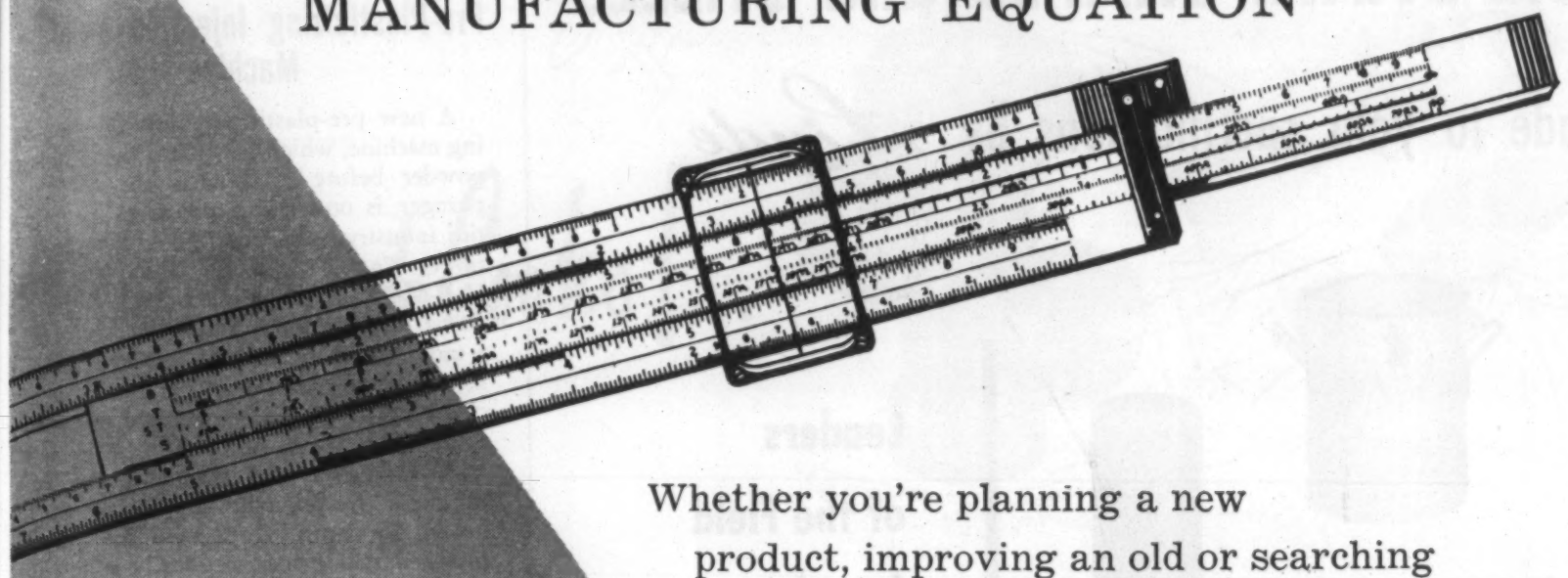
Occluded Salts from Black Oxidizing Removed by New Compound

A new compound which is claimed to completely remove occluded salts with one rinse after the black oxidizing of metals has been developed by *Du-Lite Chemical Corp.*, Middletown, Conn. Known as Du-Lite SD, this liquid compound reacts chemically on black oxide salts which often remain trapped in rough or irregular surfaces of porous, laminated, sintered or spot welded parts. If used as recommended in a bath of from 225 to 275 F, a visible boiling results from the chemical action until all salts are removed. However, the reaction does not break down the compound, which can be reused.

SD was specifically developed to overcome creeping salts, which previously have required numerous hot and cold rinses for their removal and made the black oxidizing of laminated metals impractical. Exhaustive humidity testing of parts treated with the compound produced no trace of occluded salts nor of rust, which the light coating left by the compound also prevents.

See page 17 for the Metal Show Preview

A NEW FACTOR IN YOUR MANUFACTURING EQUATION

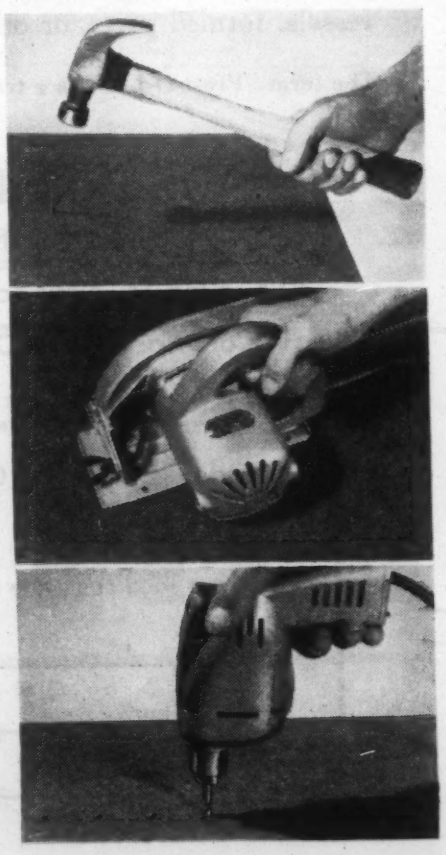


allwood* HARDBOARD

Whether you're planning a new product, improving an old or searching for an answer to scarce or expensive materials, Allwood should figure in your calculations.

Durable, dependable Allwood hardboard can be produced to answer your design problems, fit your plans or meet your manufacturing needs.

Simpson Logging Company of Seattle, Washington, are exclusive national sales agents for Allwood.



OREGON LUMBER COMPANY BAKER, OREGON

Send for FREE booklet: THE ALLWOOD STORY

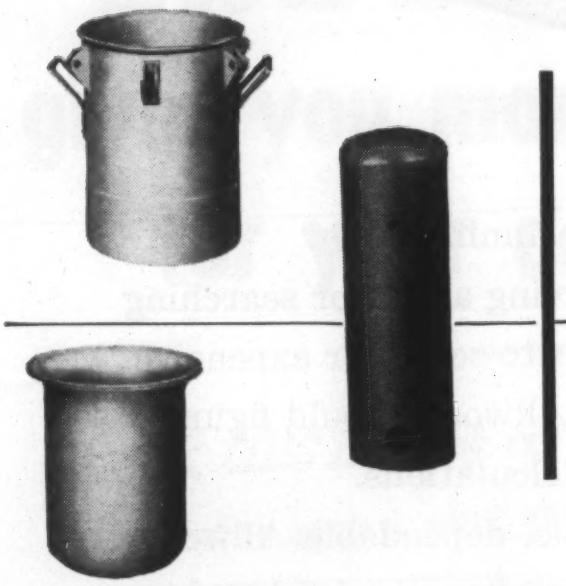
Allwood can be bent, die cut, scored, drilled, laminated, shaped, routed, planed, sawed, nailed, glued and processed in almost any way you wish or the job demands.

*Trade Mark of Oregon Lumber Company

Prest-O-Lite
Trade-Mark

Cold-Drawn SHAPES and SHELLS

made to your specifications by Linde



Leaders of the Field for Almost Half a Century

PREST-O-LITE cold-drawn shapes and shells can be quickly and economically produced to your most rigid specifications—from 1½ to 23 inches in diameter and up to 50 inches in depth. Our greatly expanded, well-equipped plant has every modern manufacturing facility and is manned by a thoroughly experienced, highly specialized staff—prime requisites of a quality product.

LINDE engineers will gladly help you solve your production and design problems involving cold-drawn shells, cups, containers, receivers, pressure vessels, formed parts, or other shapes. Mail us the coupon today.

The term "Prest-O-Lite" is a trade-mark of Union Carbide and Carbon Corporation.

LINDE AIR PRODUCTS COMPANY
A DIVISION OF UNION CARBIDE AND CARBON CORPORATION
30 E. 42nd St., New York 17, N. Y. UCC Offices in Principal Cities
In Canada: DOMINION OXYGEN COMPANY, Limited, Toronto

Linde Air Products Company S37
30 East 42nd Street
New York 17, N. Y.

Please send complete information about cold-drawn shapes and shells.

NAME_____

COMPANY_____

ADDRESS_____

New Materials and Equipment

Pre-Plasticizing Injection Molding Machine

A new pre-plasticizing injection molding machine, which plasticizes the molding powder before it contacts the injection plunger, is now being offered to the plastics industry by *Hydraulic Press Manufacturing Co.*, Mt. Gilead, Ohio. The new H-P-M Model 400-P-48 is said to have a 48-oz. shot capacity, high injection speed, a mold clamp capacity of 400 tons, a daylight opening of 54 in., a 30-in. mold clamping stroke, and large mold mounting space (25½ by 36 in. or 40 by 21½ in.).

According to the company, the unit produces exceptionally deep parts up to 14 in. in depth. And, with the quickly installed ram spacer, is ideally suited for shallow parts. Typical deep parts which can be produced include: refrigerator parts, hydrator drawers, crisper trays; table and portable radio cabinets; telephone bases; and houseware items.

Corrosion Resistant Synthetic Coating

A new corrosion resistant synthetic coating for wood, masonry and metal surfaces has been announced by the *Monroe Co., Inc.*, 10703 Quebec Ave., Cleveland 6. Known as Pozcote, the coating contains inert synthetic resins and, unlike oil paints and varnishes, it is impervious to water, acids, alkalis, alcohol, syrups, oils and grease.

The company states that the new coating is tough and long wearing, and stands up as a floor coating under heavy trucking and foot traffic. It can be used indoors or out. Because of its elasticity, it will not crack or peel from temperature changes.

Available in black, aluminum, clear, white and a complete assortment of colors, Pozcote is highly recommended for floors, walls, woodwork, furniture, machinery and equipment. It is said to be especially advantageous for use in the presence of chemical fumes, food acids, moisture and high humidity.

Look for us at the Metal Show—Booth No. 1454

We've lots of Cooks!...

and the result is better steel castings

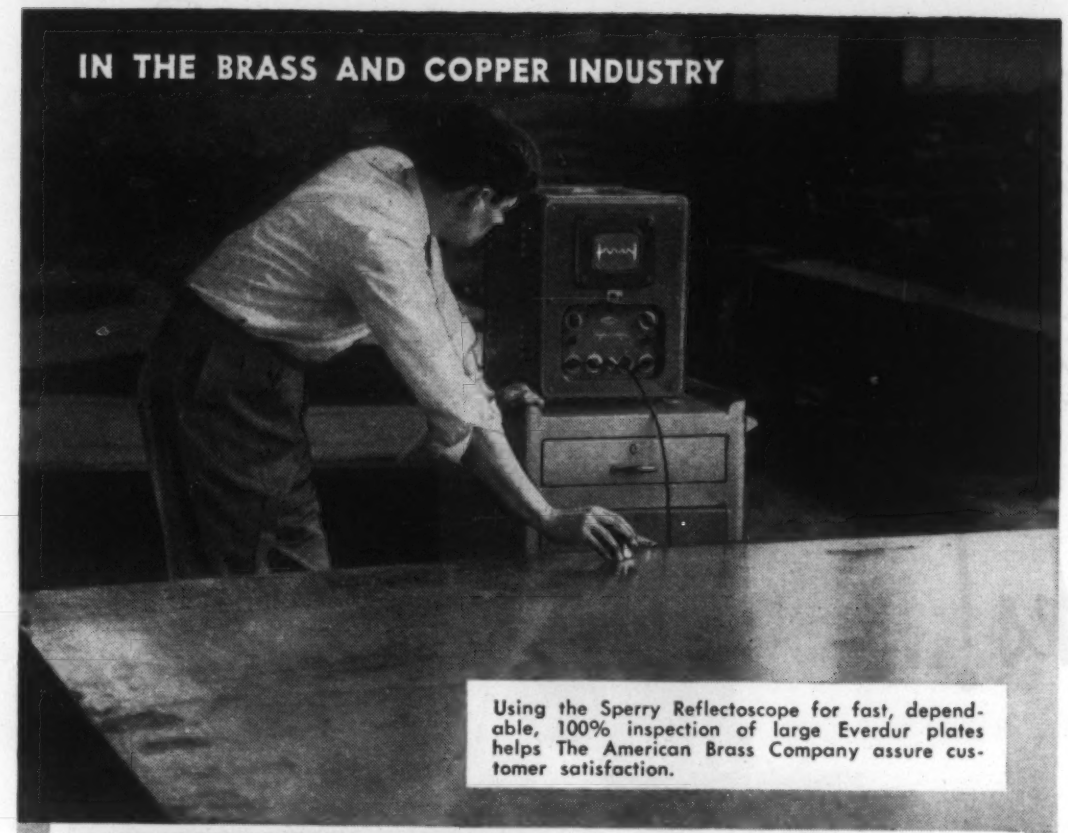
The production of Sivyer Castings is anything but a "one man show." Many cooks . . . each an expert . . . combine their talents to assure perfection in every casting carrying the Sivyer Ⓢ. The careful buyer of steel castings knows that this combination of skills plus rigid control . . . means extra economy . . . longer, more dependable service from every Sivyer casting.

The sign of a "well done" casting. Look for the Sivyer Ⓢ — your guarantee of the best in high-alloy, low-alloy, and specification steel castings.

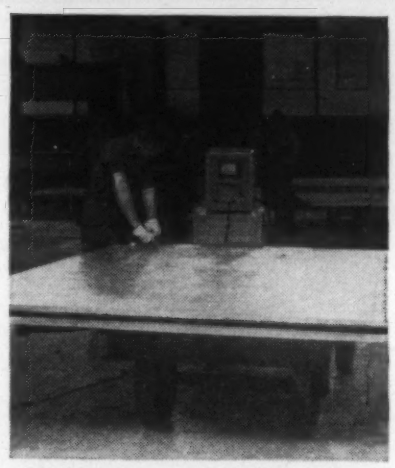
SIVYER

SPECIALISTS IN HIGH ALLOY AND SPECIFICATION STEEL CASTINGS

SIVYER STEEL CASTING COMPANY • MILWAUKEE Ⓢ CHICAGO Ⓢ MAIN OFFICE: 1675 SO. 43rd ST. • MILWAUKEE, WIS.



Using the Sperry Reflectoscope for fast, dependable, 100% inspection of large Everdur plates helps The American Brass Company assure customer satisfaction.



The versatile Reflectoscope is here used by The American Brass Company to inspect cupro-nickel condenser plates.

NO REJECTS
Since Installing
Sperry
ULTRASONIC
TESTING

Reflectoscope testing of work rolls protects against failure on the job with consequent work spoilage.

Two years ago The American Brass Company adopted Sperry Ultrasonic Reflectoscope testing for their Everdur plate. Since that time, *not a single plate* has been rejected by a customer. Accurately and dependably locating laminations and other internal defects not detectable by visual inspection, the Reflectoscope provides rapid, non-destructive testing that helps to maintain an enviable reputation for uniform high quality.

Penetrating up to 24 feet in solid metal, the Reflectoscope is also used to inspect a wide variety of other forms and materials in the brass and copper industry.

Learn how you can reduce testing costs and improve quality control in your plant. Write today for complete information about the Sperry Reflectoscope . . . for sale, or for lease. *Ask about Sperry's day to day Testing Service.*

Sperry
SPERRY PRODUCTS, INC.
410 SHELTER ROCK ROAD
Danbury, Connecticut
REPRESENTATIVES IN PRINCIPAL CITIES

New Materials and Equipment

Aluminum Alloy Designed as Replacement for Chromium Plating

An aluminum alloy that will take an unusually brilliant Alumilite finish has been developed by *Aluminum Co. of America,* 801 Gulf Building, Pittsburgh 19. Alcoa C57S, as the alloy has been designated, is said to hold great promise in the field of automobile trim. With an Alumilite coating it could be used as an attractive, economical and long-lasting replacement for chromium plating and stainless steel.

Besides taking a clear Alumilite finish of high brilliance, the alloy offers the added attraction of colored Alumilite finishes in many shades.

Although the alloy has just been announced publicly, it has been used extensively in the field of gift-ware and refrigerator trim. Alumilite-treated C57S is said to approach high-purity aluminum in the transparency, metallic luster and sheen of its finish, while affording substantially higher mechanical properties.

Reverberatory Furnace Offers New Advances In Metal Melting

Long-needed operating improvements for the melting of ferrous and nonferrous metals are now said to be provided by the newly-developed Eclipse noncrucible, direct-fired reverberatory furnace offered by *Eclipse Fuel Engineering Co.,* 1002 Buchanan St., Rockford, Ill. Testing and application show that through its continuous charge, continuous pour operation, high production quality castings can be secured in less time and at less cost than with other methods. According to the company, there is no time lost between pouring and recharging, hot metal is always available for casting, and combustion normally wasted is used for melting or preheating cold metal in the hopper.

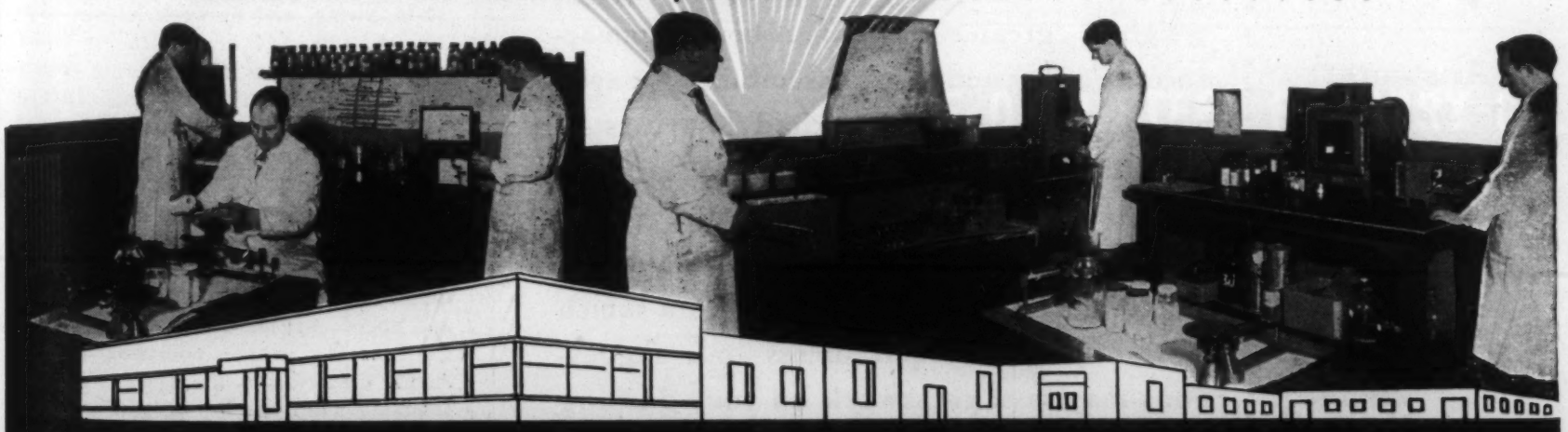
The unique design of the combustion chamber is said to achieve near perfect combustion. The hopper in which the metal is charged has a restricted opening at the bottom to prevent cold metal from contacting the molten metal. Since the metal is quickly melted, there is little chance for it to absorb gases.

The unit has proved equally efficient for large or small heats. Fired by oil or gas fuels, it can be built to meet specified requirements. Standard models, with bath capacities ranging from 300 to 4400 lb, are now in production.

IMPENDING EVENTS

MAY CAST THEIR SHADOWS

. . but whichever way the election may go—there will still be a sunny side . . for we are sure, just as in the last twenty years—metal finishers will go right on electing Northwest Chemical Company to solve their metal cleaning problems . . Through these years of attendance to basic research and sound plant practices, we have gained experience and developed products that will solve the most difficult cleaning problems. . . When you next have a metal cleaning problem, let us show you what we can do. . . Send for twenty-four page brochure that describes all of the NORTHWEST products. . . . . .



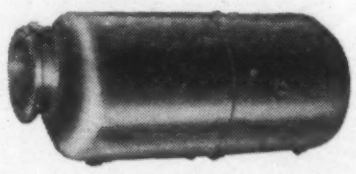
LO HI pH

NORTHWEST CHEMICAL CO.
9310 ROSELAWN DETROIT 4, MICH.

pioneers in pH cleaning control — serving you since '32

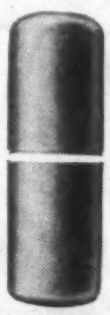
3 quick guesses here...

1



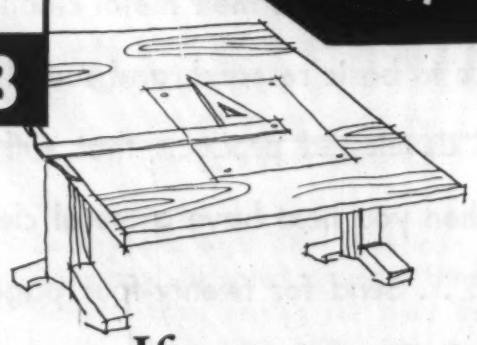
2

These three Hackney Deep Drawn Shapes are supplied by us as component parts for other manufacturers' products. Can you guess what kinds of products they are used on? (Answers below.)



3

may save you guesswork here...



If you're designing for lighter weight . . . greater strength . . . better appearance . . . easier and faster assembling—maybe we can help you. We've had 50 years of specialized experience in designing and manufacturing Hackney Deep Drawn Shapes and Shells to accomplish these very objectives for hundreds of manufacturers. Send us a sketch of your product requirements—our suggestions may save guesswork on your drafting board.

Answers:

1—*Seamless shell for a dry chemical fire extinguisher.*

2—*Air receiver for portable air compressor.*

3—*Condenser shells for refrigeration equipment.*

Ask for a complimentary copy of our anniversary booklet, "Design for Progress."

Hackney MILWAUKEE

Pressed Steel Tank Company

Manufacturer of Hackney Products

...oth St., Milwaukee 14 • 1317 Vanderbilt Concourse Bldg., New York 17
241 Hanna Bldg., Cleveland 15 • 936 W. Peachtree St., N.W., Room 111, Atlanta 3
208 S. LaSalle St., Room 788, Chicago 4 • 559 Roosevelt Bldg., Los Angeles 17

CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

New Materials and Equipment

Moly-Manganese Electrodes Offered

Supplementing its widely accepted manganese electrodes, *Stoody Co.*, Whittier, Calif., has announced the production of a moly-manganese material for manual welding and in coils for automatic electric application. The new electrodes contain 14 to 15% manganese, with deposits showing full Hadfield properties.

The physical properties of bare Stoody Moly-Manganese as deposited are as follows: Rockwell hardness of 85 to 90 B, and as cold worked, 43 to 47 C; tensile strength, 100,000 psi; yield strength, 85,000 psi; elongation in 2 in., 14%, deposits nonmagnetic.

The new electrode is designed primarily as a build-up material for manganese steel parts. Deposits of the bare rod possess maximum physical properties and have weldability closely approaching that of the conventional coated electrodes. Sizes are 14 in. in length and 5/32, 3/16 and ¼ in. in dia.

Cylindrical Grinding Machine

A new heavy duty Norton Type C-2 Cylindrical Grinder built as a plain or semi-automatic machine in 18-, 24- or 30-in. swing, and in work lengths of 48, 72, 96, 120, 144 or 168 in., is said to provide the means for lowering costs in grinding large cylindrical work. In addition to a fast grinding action, the unit, offered by *Norton Co.*, Worcester 6, Mass., offers new features that are said to reduce costs by simplifying setup and operation and by requiring less maintenance.

With the new machine, setups are quickly made because all controls for feeds and speeds are adjusted at the front of the machine in the operating position. Actual operation of the Type C-2 is considerably simplified by several important features. One of these is the combination graduated wheel feed handwheel and click-count indexing mechanism which readily indicates the amount of feed as the wheel is rotated past a fixed pointer, and permits setting of 0.0001 in. in work diameter instantly and without visual attention.

Further operating ease is provided by the pre-set truing and grinding speed arrangement. With this feature, table speeds for truing and grinding are independently

FAHRITE

HEAT AND CORROSION *Alloys*

Fahrite castings for heat-resistant applications

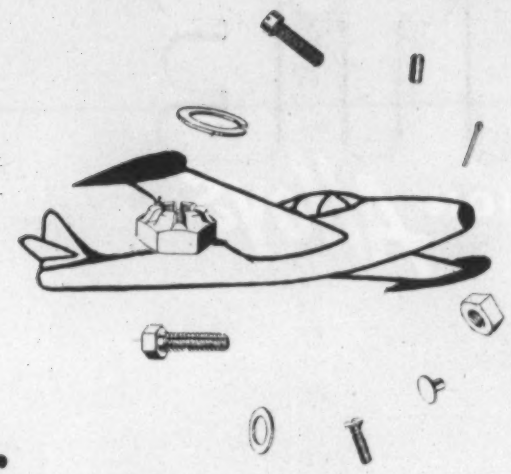
In retorts, hearths, chain, centrifugally-cast tubes and many others, Fahrite castings prove their practical heat-resisting ability. Whatever your operating conditions, a Fahrite engineer will recommend the proper-grade alloy to fill your requirements.

THE OHIO STEEL FOUNDRY CO.

SPRINGFIELD, OHIO • Plants at Springfield and Lima, Ohio

Visit **SPACE 1958**

at the Metal Show



When you think of

STAINLESS STEEL FASTENINGS

think first of

ANTI-CORROSIVE

Anti-Corrosive has millions of stainless fastenings *in stock* (probably the largest selection of varieties and sizes in the world) for *immediate delivery.* Anti-Corrosive has the exceptional production capacity that can fill your requirements beyond stock items faster, *better!*

FREE—A-N Stainless Fastening Selector

This handy slide-chart instantly identifies A-N Nos. pertaining to stainless steel nuts, screws, bolts, rivets, cotter pins, washers; gives sizes and other data. Write for "Chart 52L" TODAY!

25 YEARS OF LEADERSHIP IN FASTENINGS OF STAINLESS STEEL

Anti-Corrosive Metal Products Co., Inc.

Manufacturers of STAINLESS STEEL FASTENINGS

CASTLETON-ON-HUDSON, NEW YORK

adjustable and pre-set, and either speed is immediately obtained, when desired, by movement of a combination selector and table start-stop lever. No resetting of these speeds is necessary in the change from one to the other. Work-jogging control by means of a lever that is conveniently located near the operating position is also provided.

Either automatic or manual control of work rotation and coolant flow, and automatic adjustable wheel feed at table reversals with automatic resetting of the wheel head also facilitates ease of operation. To simplify and speed maintenance functions, all pumps and motors are placed in accessible locations outside of the machine. Electrical controls are grouped in an elevated enclosure for protection and maximum convenience.

New Melting Furnace Discharges Directly into Cold Chamber

At the National Metal Exposition this month, *Ajax Engineering Corp.*, Trenton, N. J., will show a new automatic unit for pouring accurate amounts of molten metal into molds. The Ajaxomatic is designed to discharge molten metal, particularly aluminum, directly into the cold chamber of most available die casting machines. Molten metal is taken from a point considerably below the surface of the melt, thereby eliminating any opportunity of pouring surface oxides or scum into the casting.

The unit acts as a combined holding furnace and automatic pouring unit. Temperature and alloy composition of the melt are maintained accurately by the Ajax-Tama-Wyatt inductor in the lower part of the unit, based on the principle of gentle electromagnetic stirring.

This unit is not a melting furnace. The Ajaxomatic is supplied with batches of molten aluminum from separate melting furnaces at regular intervals, thus fitting into the practice of most die casting plants where conventional hand ladling furnaces are in use. The unit can also be used for zinc alloys, pointing the way to the economic use of cold chamber machines for that purpose, if desired.

More power to you!

In the vital electrical equipment industry, as in practically all other fields, the uses for OSTUCO Tubing are countless. Transformer and header tubes, columns, bushings, bearings, housings, and mounts are only a few of the specific applications in generators, motors, starters, power equipment, and many other electrical products that mean power to you.

Whether your products are electrical or of an entirely different type, you'll be wise to investigate the advantages of OSTUCO Tubing, in improving design, increasing strength, reducing weight, and cutting cost. We cannot always promise early delivery estimates on new civilian orders, because of military demands, but it will pay you to consult our experienced engineers about OSTUCO Tubing when redesigning your products to meet future competition.

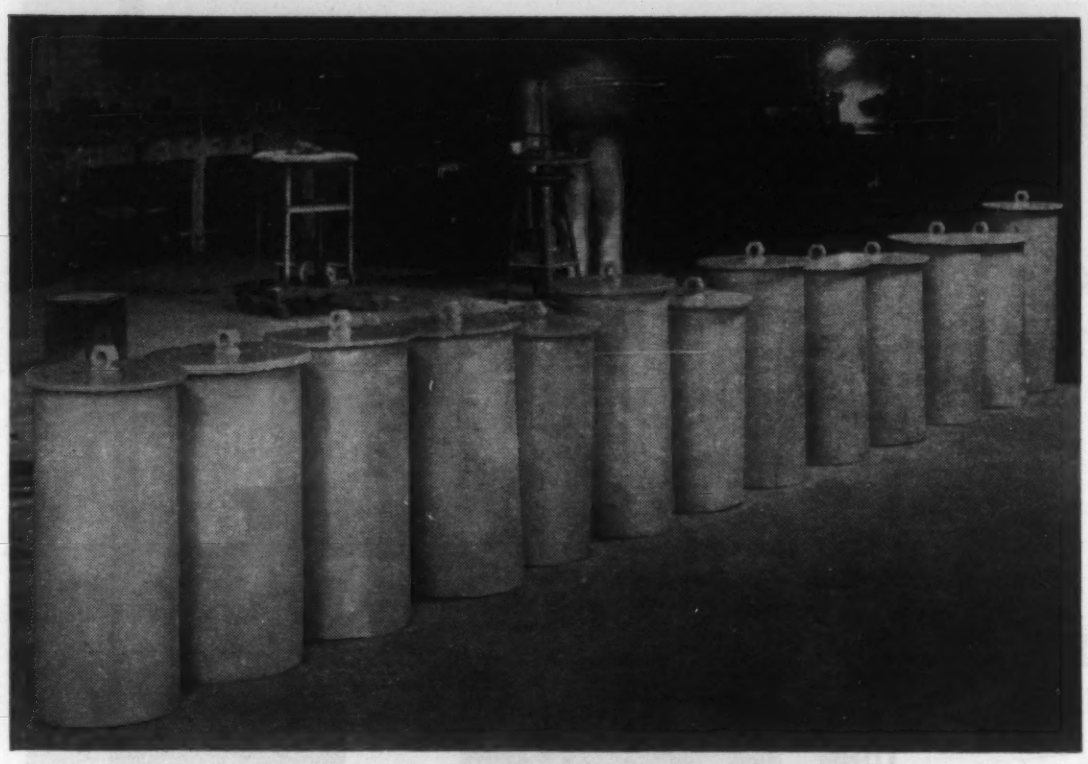
THE OHIO SEAMLESS TUBE COMPANY

Manufacturers and Fabricators of Seamless and Electric Welded Steel Tubing

Plant and General Offices: SHELBY, OHIO

OSTUCO SHELBY, OHIO

SALES OFFICES: Birmingham, P. O. Box 2021 • Chicago, Civic Opera Bldg., 20 N. Wacker Dr. Cleveland, 1328 Citizens Bldg. • Dayton, 511 Salem Ave. • Detroit, 520 W. Eight Mile Road, Ferndale • Houston, 6833 Avenue W, Central Park • Los Angeles, Suite 300-170 So. Beverly Drive, Beverly Hills • Moline, 617 15th St. • New York, 70 East 45th St. • Philadelphia, 1613 Packard Bldg., 15th & Chestnut • Pittsburgh, 1206 Pinewood Drive • St. Louis, 1230 North Main St. • Seattle, 3104 Smith Tower • Syracuse, 501 Roberts Ave. • Tulsa, 733 Kennedy Bldg. • Wichita, 622 E. Third St. • *Canadian Representative:* Railway & Power Corp., Ltd.



Shown here are heat treating pots metallized with aluminum to prevent surface damage from heat. (Metallizing Co. of Los Angeles)

Aluminizing Protects Metals at Elevated Temperatures

by L. E. KUNKLER, Metallizing Co. of America

This metal spraying process is proving practicable for many uses.

● ALUMINIZING by the metal spraying process has long been used in Europe and this country for the protection of iron and steel against oxidation at elevated temperatures. The process is used extensively on cyanide pots, salt pots, magnesium and aluminum pouring pots. burner tips. hardening furnace parts pyrometer tubes, and many other iron or steel parts which are exposed to heat corrosion.

Briefly stated, aluminizing consists of spraying a coating of pure aluminum over the areas that will be affected by heat corrosion, applying a suitable seal over the coating to prevent oxidation during the heat treatment that follows, and then heat treating the piece for a short period. During the process a compound coating is formed which is composed of three layers: (a) a solid solution of iron and aluminum fused into the steel; (b) a layer of iron-aluminum alloy. together with a slight excess of free aluminum; (c) finally, a thin coating of aluminum oxide.

There are a number of sealers which can be used, but the one which has given uniformally good results is silicate of soda, commonly known as water glass. In England, many firms use Bitumastic paint as a sealer. In France, a saturated solution of borax is well liked. In Germany, water glass is generally used. The main object of the sealer is to prevent oxidation of the aluminum while the diffusing layer is forming.

As pointed out above, aluminizing provides good high temperature protection. The outer layer of iron-aluminum alloy usually flakes away after several hours of temperatures over 1470 F. As long as the aluminum layer remains on the surface of the steel, scaling is impossible. Only when aluminized steel is heated to 1830 F is there an accelerated rate of penetration of the alu-

(Continued on page 212)

ATLANTA, Ga., Alpine 4885
Morrison-Drabner Steel Co., Inc.

BALTIMORE, Md., Peabody 7300
Hill-Chase Steel Company of Maryland
Asheboro, N.C.: Phone 8849
Richmond, Va.: Phone 7-4573

BEAUMONT, Tex., Phone 4-2641
Standard Brass & Mfg. Co.

CHICAGO METROPOLITAN AREA
Korhumel Steel & Aluminum Company
Evanston, Ill.: Ambassador 2-6700

CINCINNATI, Ohio, Wabash 4480, 4481
Morrison-Drabner Steel Co., Inc.

CLEVELAND, Ohio
Nottingham Steel Company
Atlantic 1-5100
Copper & Brass Sales, Inc.
Endicott 1-6757

DALLAS, Tex.
Delta Metals, Inc.
Hunter 7446
Earle M. Jorgensen Co.
Riverside 1761

DAVENPORT, Iowa, Phone 3-1895
Nichols Wire & Aluminum Co.

DETROIT, Mich.
Copper & Brass Sales, Inc.
Lorain 7-3380

HONOLULU, T. H., Phone 5-2541
Permanente Cement Co.

HOUSTON, Tex.
Standard Brass & Mfg. Co.
Preston 1123
Earle M. Jorgensen Co.
Orchard 1621

INDIANAPOLIS, Ind.
F. H. Langsenkamp Company
Riley 9311
Korhumel Steel & Aluminum Company
Franklin 5361

KANSAS CITY, Mo., Victor 1041
Industrial Metals, Inc.

LOS ANGELES, Calif.
Eureka Metal Supply Company
Mutual 7286
Earle M. Jorgensen Co.
Lucas 0281
Reliance Steel Company
Adams 6133

MILWAUKEE, Wis., Evergreen 4-6000
Korhumel Steel & Aluminum Corp.
of Wisconsin

MINNEAPOLIS, Minn.,
Korhumel Steel & Aluminum Company
Gladstone 5943, Prior 4030

NEW ORLEANS, La.
Orleans Steel Products Co., Inc.
Raymond 2116
Standard Brass & Mfg. Co.
Aud. 1353

NEW YORK METROPOLITAN AREA
A. R. Purdy Co., Inc.
Lyndhurst: Rutherford 2-8100
New York: Chelsea 3-4455
Newark: Humboldt 2-5566

OAKLAND, Calif.
Gilmore Steel & Supply Company
Glencourt 1-1680
Earle M. Jorgensen Co.
Higate 4-2030

OMAHA, Nebr., Atlantic 1830
Gate City Steel Works

ORLANDO, Fla., Phone 7124
Profile Supply Company

PHILADELPHIA, Penna., Delaware 6-5400
Hill-Chase & Company, Inc.
Allentown: Allentown 28077
York: York 5790

PHOENIX, Ariz., Phone 8-5331
Arizona Hardware Co., Inc.

PITTSBURGH, Penna., Hemlock 1-5803
Follansbee Metal Warehouses

PORT ARTHUR, Tex., Phone 5-9377
Standard Brass & Mfg. Co.

PORTLAND, Ore., Tuxedo 5201
Eagle Metals Inc. of Oregon

SAN FRANCISCO, Calif., Klondike 2-0511
Gilmore Steel & Supply Company

SEATTLE, Wash., Lander 9974
Eagle Metals Company

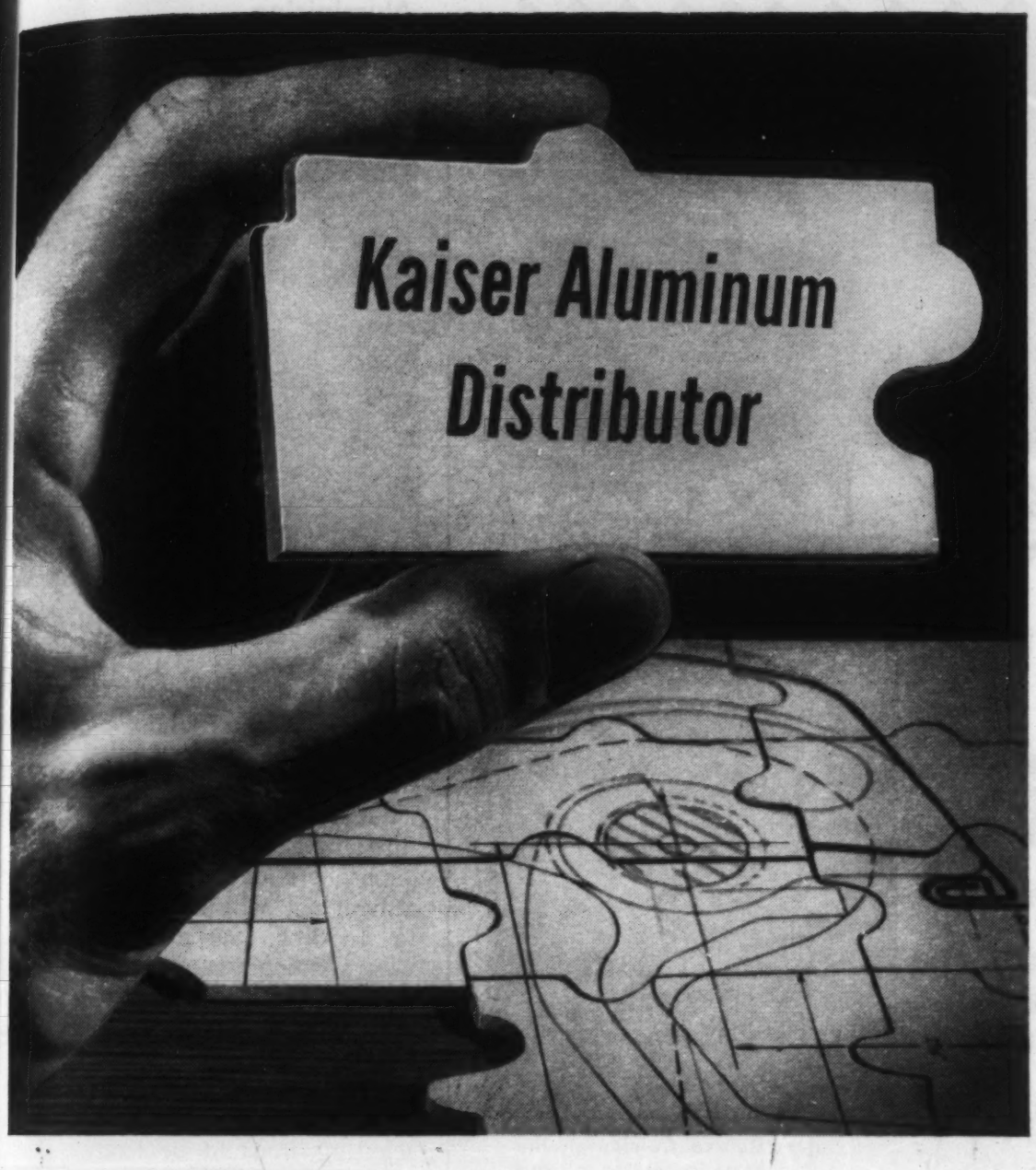
SHREVEPORT, La., Phone 2-9483
Standard Brass & Mfg. Co.

SPOKANE, Wash., Madison 2419
Eagle Metals Company

ST. LOUIS, Mo., Lucas 0051-2-3
Industrial Metals, Inc.

WICHITA, Kans., Phone 7-1208, 7-1209
General Metals Incorporated

WORCESTER, Mass., Worcester 7-4521
Merrill Aluminum Corporation



He fits into your picture

UNDER any market conditions, the *wide range of services* offered by your Kaiser Aluminum Distributor makes him an important part of your picture.

He stocks a large variety of aluminum forms to give you prompt, dependable delivery.

He puts his specialized knowledge to work on your problems—studies new methods to help you get the most from available supplies. He supplies experimental quantities and helps you meet emergency requirements.

He closely watches continually changing government regulations—will assist in obtaining sub-contracts.

Even now, he may be able to supply all the aluminum you need. For Kaiser Aluminum is completing facilities to increase its production of primary aluminum by 137%.

Why not get better acquainted with your Kaiser Aluminum Distributor *soon?*

Your nearest Kaiser Aluminum Distributor is listed at the left. Call him TODAY.

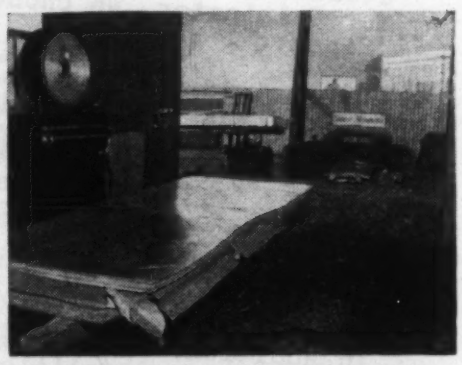
Kaiser Aluminum

Setting the pace . . . through quality and service

PRODUCERS OF: Sheet • Coil • Plate • Pig • Ingot • Billet • Foil • Electrical Conductor Residential Siding • Corrugated Farm and Industrial Roofing • Shade Screening • Rod, Wire & Bar Screw Machine Stock • Forging Stock • Rivet Wire • Roll-Formed Shapes • Extrusions

HERE'S HOW YOUR DISTRIBUTOR HELPS YOU:

MORE VERSATILE INVENTORY—Warehouse stocks give you the opportunity to select from a complete range of alloys and form—slit, sheared, or sawed to fit every production demand.



LOWER RAW MATERIAL INVESTMENT—Daily delivery eliminates tying up your dollars in idle or obsolete inventory; improves your current capital position.

LOWER COSTS—Specialization of warehouse plant and handling equipment permits deliveries at lower cost at machine side, cuts stock keeping and accounting costs.

SMALLER SPACE REQUIREMENTS—Space necessary to house your average raw material inventory can be devoted to production. Becomes a source of income rather than an expense.

Sicon in colors withstands 500°F.

SICON, THE ORIGINAL SILICONE HEAT-RESISTANT FINISH, IN GLEAMING WHITE AND TAN PROTECTS SURFACE OF HOME INCINERATOR

Here's what the makers of Calcinator say about **SICON**

"In keeping with the high standards we wished to attain for Calcinator, we chose 'Sicon.

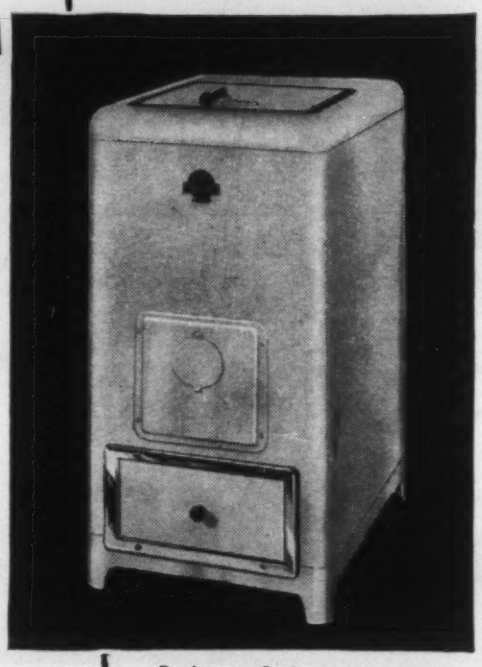
Under rigid perfection tests 'Sicon' was found to have:

1. High resistance to heat when exposed to temperatures ranging from 400 to 500°F.

2. Exceptional color as well as gloss retention qualities.

In addition, only 'Sicon' had good inherent qualities of adhesion and film stability."

W.M. Milbourne, Sales Mgr., Calcinator Division Valley Welding & Boiler Co., Bay City, Michigan



Deluxe Calcinator, the home incinerator so smart looking that it can be placed right in the kitchen. Finished in SICON White.

Standard Calcinator, for utility room or basement location, features latest advances in incinerators. Finished in SICON Tan.

SICON STANDS UP WHERE OTHER HEAT-RESISTANT FINISHES FAIL!

In case after case, for product after product, SICON has proved to be the *only* heat-resistant finish to pass all tests—in the laboratory and on the production line.

Sicon, in smart decorative colors, now opens up a new horizon for design engineers, because only Sicon makes it possible to combine "eye appeal" with retention of color and gloss in the presence of sustained heat.

No matter how rigid your heat-resistant finish requirement, *try* Sicon, the original silicone-base finish that has revolutionized product finishing wherever high temperatures pose a problem.

Write for brochure and complete engineering details.

Sicon

Silicone-Base Heat-Resistant Finish

manufactured exclusively by

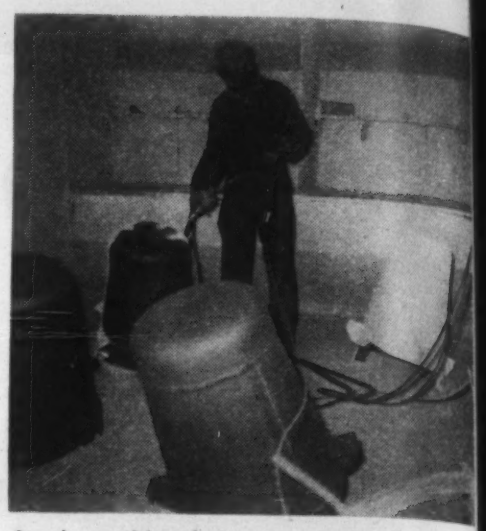
MIDLAND INDUSTRIAL FINISHES CO.

Waukegan, Illinois

VARNISHES • ENAMELS • LACQUERS • SYNTHETICS

Aluminizing . . . .

Continued from page 210



Steel crucibles being sprayed with aluminum. (Eastern Metallizing Co.)

minum into the steel, which reduces the percentage of aluminum in the coating sufficiently to allow oxidation to commence.

Generally speaking, an aluminized part should not be used in an atmosphere of much over 1380 F, although it will resist oxidation up to 1650 F. Surfaces impregnated with aluminum also resist attack of gases, and spraying of nickel-bearing alloys with aluminum prevents sulfurizing.

While mild steels are readily aluminized, care must be used in selecting irons to be treated. Most grades of cast iron grow under the influence of prolonged heating, and as the aluminum oxide skin cannot grow at the same time, a crazed effect is obtained and oxidation proceeds along the lines where the aluminum oxide skin has fractured. Therefore, an iron not subject to growth is advisable.

Care must also be used in selecting irons for temperatures above 1470 F. At these higher temperatures, when aluminum comes in contact with graphite present, the iron will be converted into aluminum graphite and will also mix with sulfur and aluminum sulfite. A chemical reaction of this sort may prove very detrimental to the protective layer as the newly formed aluminum compound will produce only a negligible degree of adhesion to the base metal.

Aluminizing has found successful use for prolonging the life of aircraft manifolds. In this and other uses, such as exhaust manifolds on gas engines or stoker tuyeres, and cast iron fire walls, it is unnecessary to use a sealer. The stacks are blasted, sprayed with 0.008-in. pure aluminum. The heat from the ex-

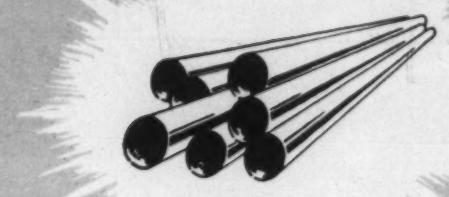
(Continued on page 214)

Brass and Copper Tubing that will LAST...

the many types of brass and copper tubing ich H & H manufactures, none serves in a wider iety of applications than METALFO, the AZED BRASS tubing pictured at the right. Origi- ed and manufactured exclusively by H & H, ETALFLO is used in place of seamless tubing erever economy is a factor—whether it be in automotive field as illustrated below, or in manufacture of machines, motors, bathroom tures, truck or tractor equipment. If *your* oper- on calls for brass and copper tubing or fabri- ed tubular parts that will *last*, it will pay you talk to H & H *first*. Why not contact your arest H & H representative today?

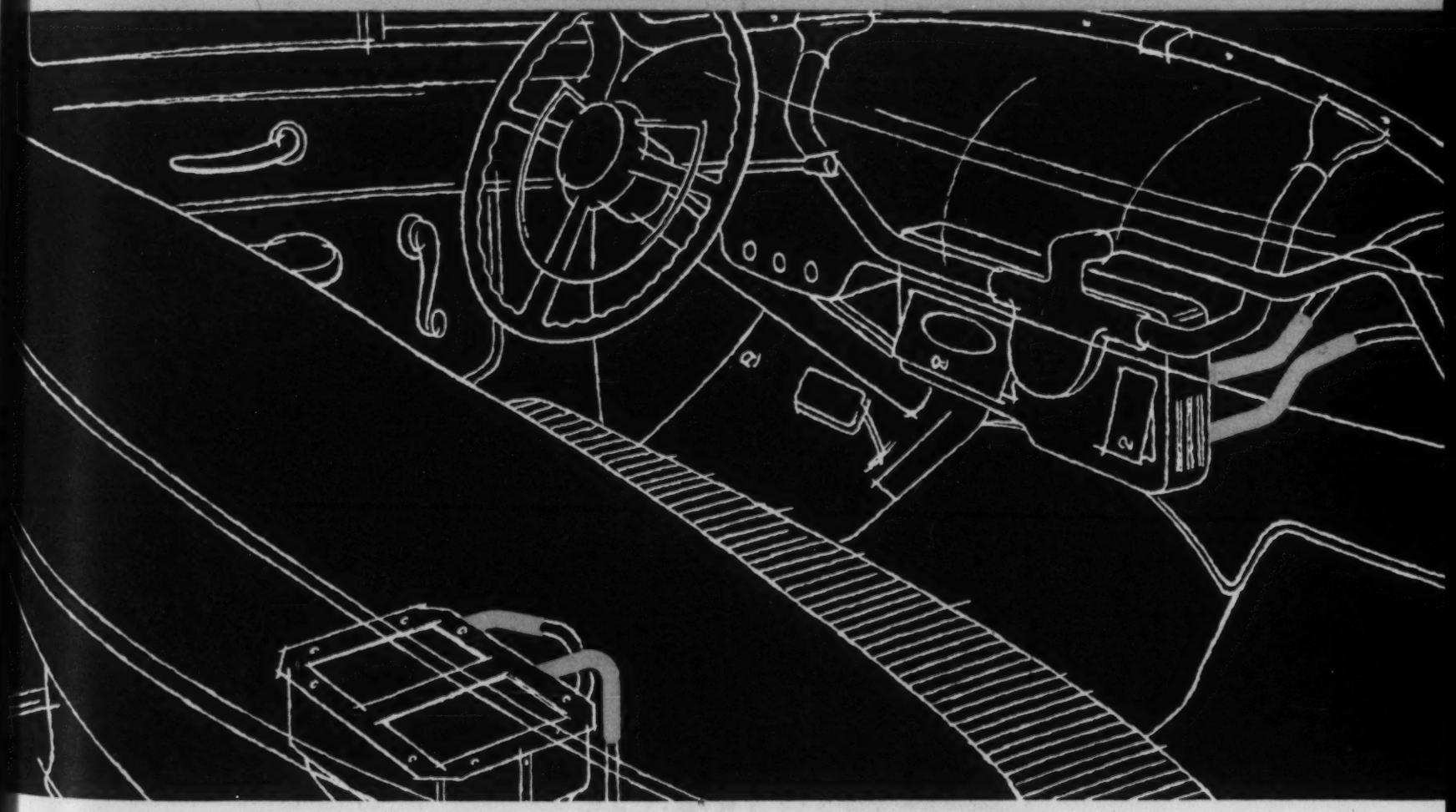
H&H TUBE AND MANUFACTURING COMPANY
252 North Forman Avenue, Detroit 17
Originators and sole makers of "Metalflo"—the economy tubing

Think of
H&H
First



METALFLO
(BRAZED)

METALFLO is fabricated in O.D.'s of ¼" through 1¼" in wall thicknesses of .035" and lighter. It is also available in cut or random lengths, or formed to your specifications.



METALFLO LOCKSEAM COIL STRIP AND SEAMLESS TUBING TUBULAR PARTS

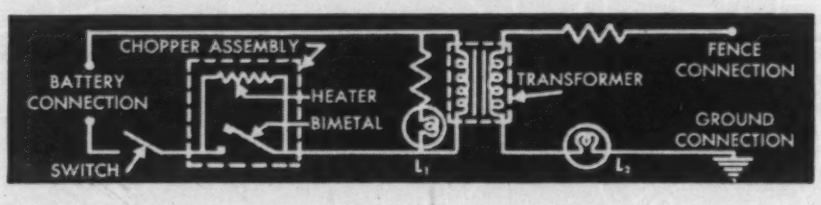
SEE **METALFLO** AT THE **METAL SHOW** • BOOTH 1487

Visit our interesting display of tubing and fabricated parts at the National Metal Exposition in Philadelphia, October 20-24.

CHACE cuts current 3,400,000 times

Product of International Electric Co. Chicago, Illinois

The International Electric Fencer Model No. 106 keeps livestock under control by supplying an intermittent electrical charge to the fence line. This is especially advantageous to farmers in protecting crops and maintaining barn control. The device known as the "chopper" contains the bimetal actuating element and is rated at 3.4 million interruptions or 2000 hours of continuous operation. The reliability of the Fencer is largely dependent upon the actuating element of Chace Thermostatic Bimetal.



The chopper assembly consists of a straight bimetal element with contact in parallel with a resistance wire heater wound around the bimetal. Normally, the contacts are open so that initial current flows through the heater to cause the bimetal temperature to increase and move to close the contacts. This closing action shorts out the heater and decreases the temperature in the bimetal which then returns to its original open position. The current again passes through the heater to start the next operation cycle. A green light flashes during normal operation; and a red light flashes whenever the fence is grounded or the controller is shorted.

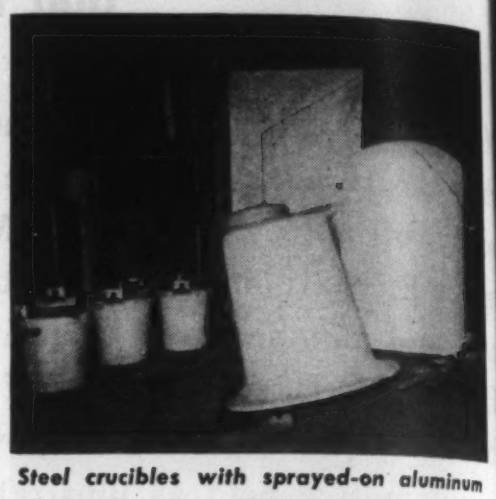
If the actuating element for your new control device is thermostatic bimetal, Chace is equipped to fabricate it ready for assembly. Our 29 types of bimetal are available in strips, coils, random long lengths and welded or brazed sub-assemblies. We invite you to consult with our Application Engineers, recognized authorities on temperature responsive devices — or write for our new 32-page booklet, "Successful Applications of Chace Themostatic Bimetal," containing condensed engineering data.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

Aluminizing . . . .

Continued from page 210



Steel crucibles with sprayed-on aluminum of outside surface. (Eastern Metallizing Co.)

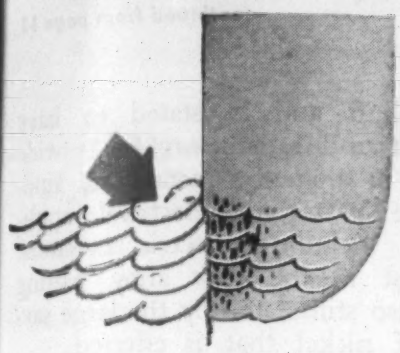
haust will give the aluminizing effect without having to use a sealer.

An application which demonstrates the effectiveness of aluminizing is the coating of hardening boxes as a protection against heat corrosion. The effective service of these pots can be increased as much as four or five times if the outside surface is sprayed with 0.008 in. of aluminum and afterwards the sprayed coating painted with three coats of water glass, allowing each coat to dry thoroughly. When placed in an oven and brought up to a temperature of 1650 F for 15 min, a protective coating is formed on the outside of the box which will be highly resistant to elevated temperatures. The cost of making this application is small compared with making a new box.

How to Aluminize Iron or Steel

1. Prepare the piece to be aluminized by blast cleaning with sharp steel grit or sand.
2. Apply an aluminum coating 0.006 to 0.010 in. thick, using only pure aluminum (99% pure).
3. Brush part with, or dip into a solution of sodium silicate (water glass) and allow the water glass to dry thoroughly. Apply a second coat of sealer.
4. Place part in a radiant heat furnace (indirect flame). Raise furnace temperature as quickly as possible to 1470 F. Leave in furnace, at this temperature, for 20 to 30 min and then remove.
5. When removed, the part should be shielded from draughts and allowed to cool at room temperature.

Beat Erosion...

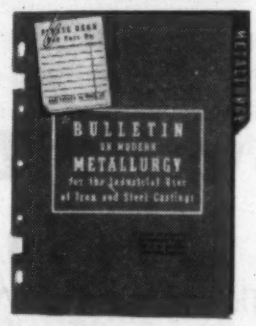


GUN IRON CAST PARTS

The proof of Gun Iron's erosion resistance has come from a wide variety of applications. One typical example is the case of cylinder liners for diesel engines. Chemical impurities in the water used for coolant cavitate ordinary liners to the point where they are useless long before worn out. Gun Iron liners satisfactorily withstand erosion and at the same time give longer wear on the cylinder wall. Users report tremendous savings in maintenance and replacement costs.

If *your* cast parts are subjected to frictional wear, heat, pressure or erosion, it will pay you to investigate Gun Iron. Our engineers are ready to assist you in determining its value. **HUNT-SPILLER MANUFACTURING CORP., 371 Dorchester Ave., Boston 27, Mass.**

Canadian Representatives: Jos. Robb & Co., Ltd., 4050 Namur St., Montreal 16, P.Q.



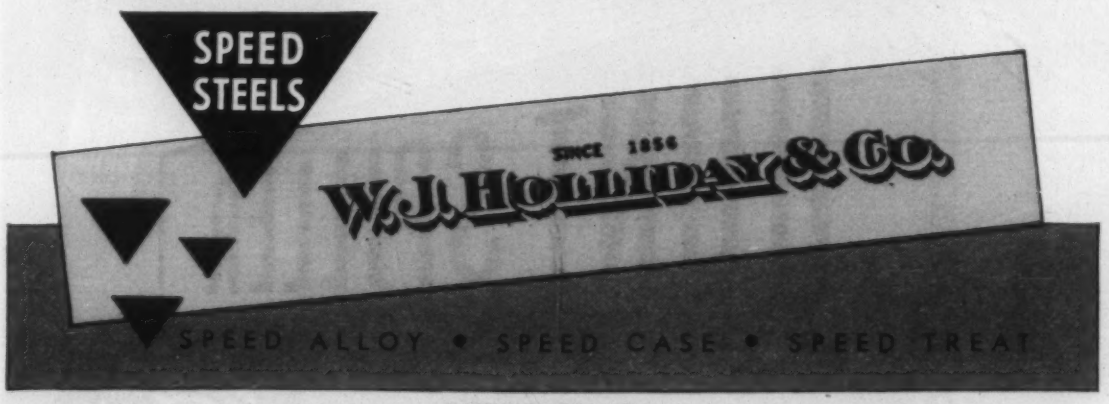
***HERE IS A PRACTICAL GUIDE** for the user of iron and steel castings . . . 24 pages of technical data on many types of metals and alloys. Write for your free copy.*

How *SPEED CASE* Boosted A Valve Maker's Sales!

These "Seat-Seal" Valves are used by petroleum refiners. Sales competition is stiff and they have to be better than good, holding bubble-tight for thousands of openings and closings under a pressure of 2000 p.s.i.g. Nearly 300 of them are shown on a Texas tank car loading rack.

Holliday's Speed Case (X1515), one of the "Time-Saver" Speed Steels, is used to make the valve bodies. Its outstanding machinability and smooth finishing characteristics are making possible operations under this sustained high pressure . . . at costs well within Grove's competitive market. "The free machining qualities of Speed Case assist materially in enabling us to maintain our competitive position in a highly competitive market," reports Grove Regulator Company, Oakland, Calif., manufacturer of the valves.

Perhaps your own needs can be profitably served by these versatile steels. While demand often exceeds supply, it will pay you to check with your Speed Steel Distributor today. W. J. Holliday & Co., Inc. Speed Steel Plate Division, 120 139th St., Hammond, Indiana.



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Brown-Wales Co., Cambridge-Hartford-Auburn, Me. - Bridgeport Steel Co., Milford, Conn. Beals, McCarthy & Rogers, Buffalo, N. Y. - Burger Iron Co., Akron, Ohio - Grammer, Dempsey & Hudson, Inc., Newark, N. J. - Earle M. Jorgensen Co., Los Angeles-Houston-Oakland-Dallas - Passaic County Steel Service, Inc., Paterson, N. J. - Peckover's Ltd., Montreal-Toronto - Peninsular Steel Co., Detroit, Mich. - Pidgeon-Thomas Iron Co., Memphis, Tenn. - Horace T. Potts Co., Philadelphia-Baltimore-York, Pa.

Produced by W. J. Holliday & Co., Inc., Speed Steel Plate Division, Hammond, Indiana. Plants: Hammond and Indianapolis, Indiana

News Digest

continued from page 13

chromium and is stated to have been found satisfactory for a wide range of domestic metalware, automobile parts and electrical appliances, including electric radiators. Interest in the new alloy plating was also stimulated by the large saving of nickel that is effected.

Another alloy of tin, tin-zinc, in the proportions 80/20, has been adopted more generally as a protective plating for radio and television apparatus and for mechanical parts and fitments of cars, cycles, tools and machinery. Other new alloy coatings are being investigated.

Bearing alloys under examination included a selection of aluminum-tin alloys which were found to have fatigue resistance superior to tin-base babbitt.

Tin-plate investigations include work with an electrolyte circulating at speed past a fixed steel specimen —the reverse of industrial practice. Estimation of the corrosion resistance of the product by rapid methods has also been studied profitably.

Further progress was made with the equipment for producing bars, rods and thick-walled tubes of bronze by casting molten bronze by a semi-continuous method.

A new pewter that can be hardened by heat treatment was announced during the year and has been well received in the trade.

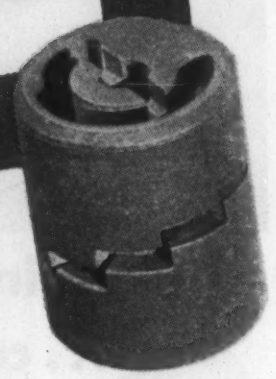
Alcoa to Install Rolling Mill for Wide Sheet

A huge new rolling mill, costing approximately $4,500,000 and capable of producing extra-wide tapered sheet and plate for aircraft, will be installed at the Aluminum Co. of America's Davenport, Iowa, works by late 1953.

Equipment for the mill—which will be one of the largest and most modern in the aluminum industry —will be designed, installed and operated by Alcoa under terms of a lease arrangement with the United States Air Force's Air Materiel

Precision casting news

from Arwood



The cam drum illustrated is typical of Arwood designing for economy. The machining and tricky assembly of thirteen component parts previously used in its manufacture has now been eliminated.

by Arwood Engineers

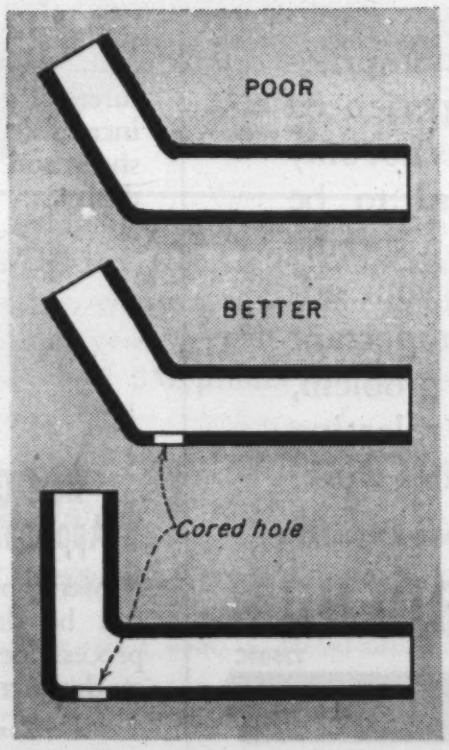
Arwood engineers work in many industries analyzing and solving problems. If you have a particular design or production problem, why not discuss it with us? Our engineering staff is at your service without any obligation whatever.

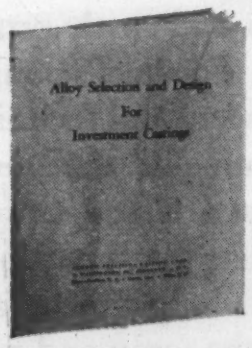
H. B. BROWN

Henry B. Brown—the Arwood "Star Man" serving New England—has applied Arwood efficiency principles to his own job. By installing a mobile telephone in his car he is able to maintain contact with his customers at all times. Faced with time difficulties, he bought an airplane, learned to fly it, and now uses it both on customer calls and delivery of parts when time is short.

TIP TO DESIGN ENGINEERS

Cored holes shown serve to support the internal core and make possible uniform walls throughout.





For more complete information write for our booklet, "Alloy Selection and Design for Investment Castings", and visit our booth, No. 1758, at the National Metal Exposition in October in Philadelphia.

ARWOOD

PRECISION CASTING CORP.

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...cut fabricating costs 23.9%
by letting
Fansteel
fabricate our
TUNGSTEN and MOLYBDENUM
COMPONENTS

A short molybdenum rod (1) was hot forged to form basic cone (2), and the part (3) was finished by machining and drilling.

More and more tungsten and molybdenum users are finding Fansteel fabrication the answer to complicated and costly production problems. Fansteel's long-experienced engineers and technicians not only recommend the material to be used but also the shape best adapted to solve a specific problem. Why not use Fansteel fabrication to your advantage, too? Fansteel will help you effect important cost savings by eliminating the scrap and reject problem, minimizing inspection costs, and releasing equipment and personnel for other work.

FANSTEEL WORLD'S LARGEST PRODUCER OF REFRACTORY METALS

Write for the informative booklet: "FANSTEEL TUNGSTEN AND MOLYBDENUM"

TUNGSTEN & MOLYBDENUM

22503C

Fansteel Metallurgical Corporation NORTH CHICAGO, ILLINOIS, U.S.A.

News Digest

Command. The Air Force, in turn, will have first call on production of the new mill. The mill, capable of rolling widths up to 10 ft through four-high stands of rolls, will be able to handle hot or cold ingots, and it will be reversible. Davenport was selected as the mill site because of the other ultra-modern facilities already existing there, such as large heat treatment furnaces and wide continuous rolling equipment. Supplementary facilities, including an intermediate leveller and pre-heat and aging ovens, are provided to complement the rolling mill.

Tapered sheet and plate are used in fabrication of aircraft wings. The sheet's thickest end is placed nearest the fuselage of the plane; thus, the sheet tapers thinner as it reaches toward the wing tips, where not as much strength is required. The principal design advantage of tapered sheet and plate over that of uniform thickness sheet or plate is a weight saving up to 35% without loss of strength.

Tapered sheet on the new mill will be produced in lengths exceeding 33 ft. Present equipment limits the production of rolled tapered sheets to widths slightly over 5½ ft and to lengths a little over 25 ft. The extra wide and long sheet can replace two or three narrower sheets and thus eliminate many costly joining operations during construction of both civilian and military aircraft.

Success of the rolled tapered sheet and plate process developed by Alcoa and the acceptance of both products by aircraft manufacturers are indicated by substantial increases in use of rolled tapered sheet and plate by the aircraft industry.

New Quick Drying Process Applicable to Many Materials

Many paints, inks and varnishes can be dried rapidly with a new process developed by two scientists at the Armour Research Foundation

(Continued on page 222)

working on Aircraft Contracts?

With more and more companies working on aircraft parts and assemblies, this booklet is extremely valuable and timely. Listing major 3M adhesive, coating and sealer applications, this booklet is based on 15 years' experience in the aircraft industry . . . and shows how 3M products, experience and engineering can help you.

Be sure to send for your copy. Write 3M, Dept. 610, 411 Piquette Avenue, Detroit 2, Michigan . . . . . .

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combine to make Iridite the most economical chromate finish you can buy. Many Iridite chemicals are packed in powder form, thus can be shipped to you in steel pails at freight savings of up to 75%! Pails take less storage space, are easier to handle, eliminate carboys, need not be returned.

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West Coast Licensee: L. M. BUTCHER COMPANY

News Digest

of the Illinois Institute of Technology. Where current industrial drying methods (heat or solvents) take hours, the new process, called "Chem-Dry," does the job in from 2 to 20 sec. Clark E. Thorp, chairman of chemistry at the Foundation, and Layton C. Kinney, assistant chairman, developed the process for Meyercord Co., of Chicago.

The vapor makes drying practically instantaneous, it is claimed. It reacts with pigment oils as coated materials are transported through an enclosed drying chamber on an endless belt. The drying period depends upon the paint, ink or varnish used and the material it coats, which may be paper, cloth, metal, wood, glass or plastic. After treatment in the chamber, coated materials are dust and tack free, can be handled, stacked, packaged, or given a second coat.

Meyercord engaged the Foundation to find an improved method of drying decal inks, which take from 24 hr to as much as a week to dry by conventional methods. Thorp and Kinney investigated more than a dozen chemicals and other methods of drying, including electron bombardment, infra red, ultra violet, and dielectric heating. Sulfur dichloride vapor, which dries decal sheets in 2 sec, proved to be the answer. Subsequently, the process was extended to other coatings and materials. Sulfur dichloride is cheap, about 11¢ a lb. The new process, which does not damage paper or many other coated materials if promptly purged, achieves two things. It speeds up production and releases plant space formerly used for drying for other purposes.

The new process suggests a number of applications, including the manufacture of oil cloth, linoleum, finishing of furniture and appliances, license plates, and many types of printing.

NACA Research Abstracts

The National Advisory Committee for Aeronautics recently published several papers of interest to materials engineers. These docu-

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

ARBON TOOL STEEL—
oolmakers' First Choice

many tool steels have been developed special applications that some people erlook the many uses for carbon tool els. Actually they're used in larger antities than any other type of tool el. An experienced toolmaker usually nsiders them first, recognizing that they the logical steels for a starting point.

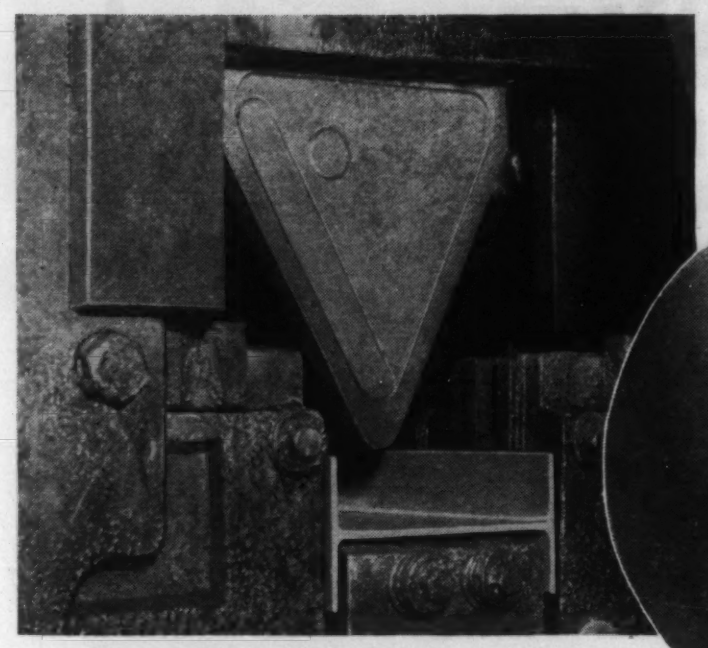
Here's why carbon tool steels are so pular:

- Easiest to machine of all tool steels
- Easy to heat-treat
- High surface hardness reinforced by a tough core
- They develop keen cutting edges

nd chisels, center punches, and vari- shock tools are usually made from rbon tool steel having a carbon content from 0.75 to 0.85 pct. Other ranges of rbon content: 0.90 to 1.00 for cold- ading dies; 1.00 to 1.10 for general- rpose tools and dies (this is the most equently used analysis); and 1.15 to 25 carbon for stone-dressing tools, awing dies, etc. Our carbon-vanadium els, containing an addition of 0.15 to 25 pct vanadium, have similar applica- ons in many instances.

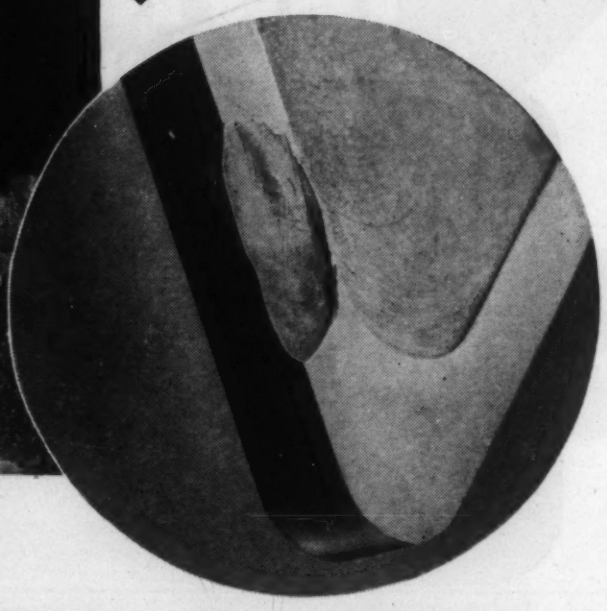
The controlled hardenability and sphe- idized structure of all Bethlehem car- n and carbon-vanadium grades assure iform response in heat-treatment. Our tensive metallurgical research has es- blished the ideal degree of harden- ility for a wide range of applications. our nearest Bethlehem distributor and r mill depot are at your service when u need top-quality carbon tool steel.

easy to machine this chamfering tool holder be- use all Bethlehem carbon tool steels are carefully heroidize-annealed to provide a structure that's al for easy machining, easy heat-treatment.



After the triangular blade descends and shears a coupon from the web of the steel beam, it moves first to the left and then to the right to shear off the flanges. The lower knife is not visible.

The edge of this shear blade chipped because of misalignment which allowed it to strike the bottom blade. Heat-checking, caused by unexpected high temperatures, is also to blame for such failures.



When cold cuts make hot blades

The shear blades usually lasted about one week in a fabricating shop where steel beams and channels were cut in large quantities. Bad spalls on the cutting edges made it necessary to change blades about once a week, and it was taken for granted that little could be done to make them last longer.

One of our metallurgical men learned of this while in the shop on another job. He began to investigate and soon found that the "cold" cutting was generating about 700 F on the blades. This caused the tool steel to develop heat-checks. In addition, the blade was overloaded due to poor alignment which allowed it to strike the bottom blade. The combination of heat and overload explained the poor service life.

The solution: Hot-Work 8, one of our hot-work steels, was tried. It's an 8-pct molybdenum analysis that's tops in wear-resistance when operating temperatures are high. Tempered at 750 F, the first blade made a total of 45,000 cuts. The best previous record was 7,700 cuts.

Here's another instance of how the practical experience of our metallurgical contact men helps to put the finger on tool steel troubles.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Heat-treat the tool, not the thermocouple

Improper temperatures during heat-treating frequently cause tool failures. In many instances the thermocouple chart shows proper heat-treatment temperatures, but the microstructure of the tool proves that the temperatures recorded were not attained by the tool. This is known as "heat-treating the thermocouple instead of the tool."

Most furnaces show some non-uniformity of temperature — locations near the source of heat are hotter than remote locations and the bottom tends to be colder than the top. A survey of each furnace will reveal the temperature differences which are present. This information makes it possible for the operator to select the location which will indicate most accurately the temperature of tools heated in the furnace; quite often the need for more than one thermocouple is apparent.

A thermocouple indicates the temperature of its tip only, so it's good practice to place the tip of the thermocouple as near to the tools as possible. Locations near the floor, sides, roof, or near the source of heat should be avoided. The thermocouple is an accurate and highly useful device, but it's not foolproof.

a $ure $hot for $avings

14 REASONS WHY PRECISION FINISHING COSTS LESS WITH THE NEW LIQUAMATTE

Mechanical equipment for producing close tolerance finishes has finally been perfected. "Hand" finishes are now produced mechanically in a matter of seconds in the new Liquamatte without the operating difficulties usually encountered in these processes. A simplified method of wet blasting, the new Liquamatte has 14 advanced design features that lower finishing costs.

Typical heat treated forging die, one half of which has been cleaned with the Liquamatte using a fine mesh Liquabrasive.

The Liquamatte is easier to start and more convenient to operate. Work can be handled faster with less effort and with far less down time. As a result, the Liquamatte uniformly removes scale and grinding lines at a new low cost. It cleans tools, dies and molds with greater efficiency while holding tolerances of .0001"

We believe the Liquamatte is the greatest advancement in close tolerance finishing in many years. We'd like the opportunity to prove it to you.

THE 14 WAYS *the Liquamatte simplifies wet blasting are described in Bulletin 23. Send for your copy today.*

American LIQUAMATTE WET BLASTING

WHEELABRATOR & EQUIPMENT CORP.

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News Digest

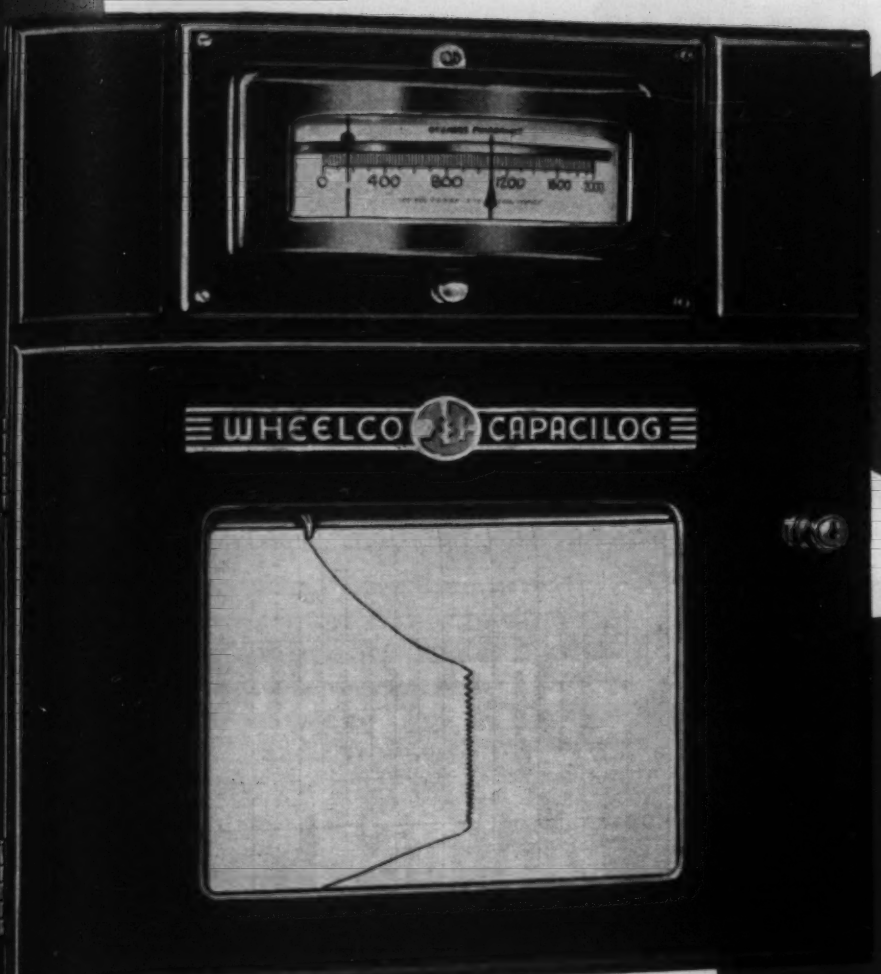
ments can be obtained from the NACA, 1724 F St., N. W., Washington 25, D. C. The papers and their abstracts follow:

"Influence of Chemical Composition on Rupture Test Properties at 1500 F of Forged Chromium-Cobalt-Nickel-Iron Base Alloys." J. W. Freeman, J. F. Ewing and A. E. White, University of Michigan. (NACA TN 2745) Sixty-two alloys involving systematic individual variations of ten elements present in a forged chromium-cobalt-nickel-iron-base alloy in the solution-treated and aged condition and simultaneous variation of molybdenum, tungsten and columbium were rupture tested at 1500 F. It was found that the elements can be varied individually between quite wide limits without significantly changing the rupture properties. The results were similar to those previously obtained at 1200 F (NACA Rept. 1058) except that increased chromium was not beneficial at 1500 F and the saturation effect for molybdenum and tungsten did not occur at 1200 F.

"Preview of Behavior of Grain Boundaries in Creep of Aluminum Bicrystals." F. N. Rhines and A. W. Cochardt, Carnegie Institute of Technology. (NACA TN 2746) Gliding of aluminum bicrystals along their mutual boundary was studied during creep tests at 392 to 1202 F and 1 to 100 psi. The direction of motion depends only upon the direction of maximum resolved shear stress in the boundary plane. The magnitude of the motion increases with magnitude of resolved shear stress, temperature, and degree of mismatch between orientations of the crystals. Gliding rate is cyclic, and for each temperature there is a stress below which gliding does not occur. At low temperature and small orientation difference an induction period precedes gliding. Gliding operates in a relatively thick zone of crystalline metal on both sides of the boundary. Portions of the grains away from the boundary degenerate into blocks that move with respect to each other, parallel to the tension axis, and that rotate about octahedral axes of the original crystal.

"Royal Aircraft Establishment (Great Britain). The Rheology of

engineered simplicity



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eered simplicity gives operating accuracy and anical stamina to Capacilog Recorder-Controllers.

ation of mechanical clamping mechanism between ting pointer and control unit allows instantaneous ding action. Design simplicity confines moving parts minimum; maintenance is easy, mechanical wear is gible. An added convenience is the plug-in chassis facilitating quick replacement.

cilog strip chart Recorders are available with high or low temperature measuring systems for ical or pneumatic control. Write for Bulletin C2-2.

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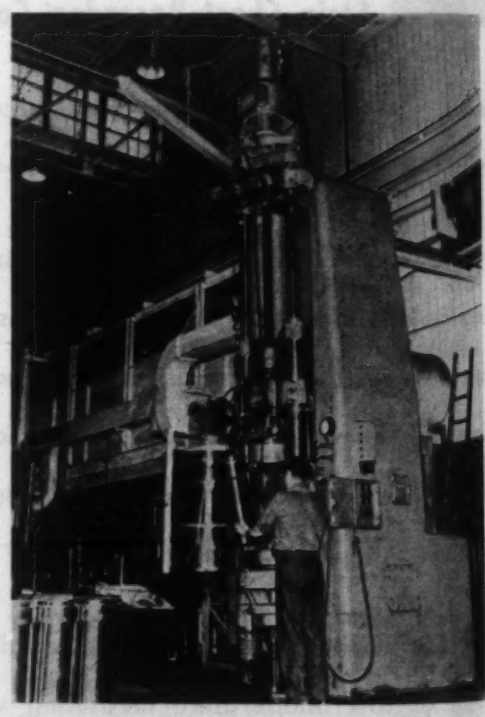
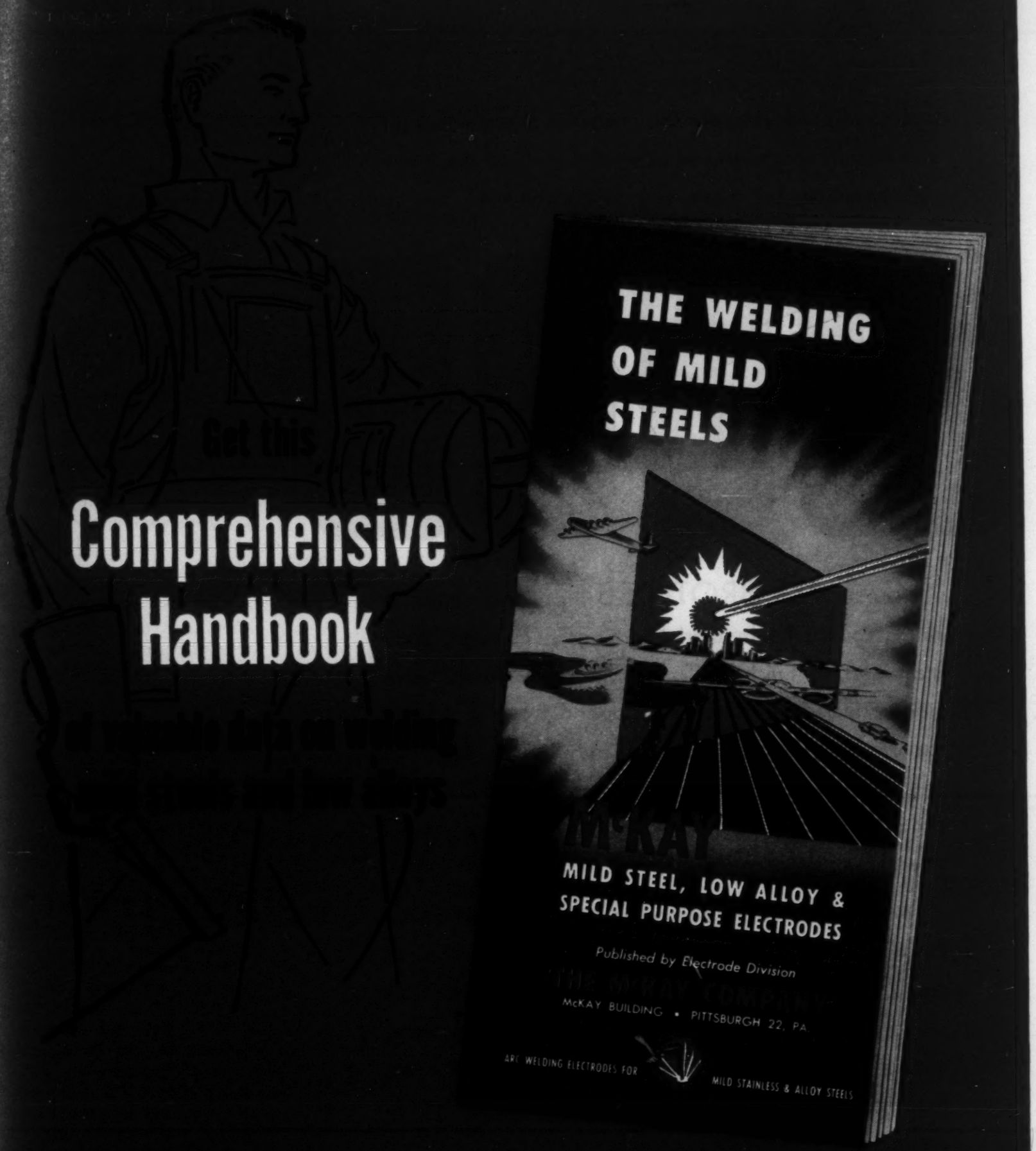
News Digest

Lubricant Films. Part 2." E. Bielak and E. W. J. Mardles. (RAE Chem. 480). This report presents further results on the rheological properties of thin lubricant films (including greases) moving between surfaces, with special regard to the influence of the material of the surfaces on the rate of flow. The limitation of Amontons' law to pressures above 100 g/sq cm for lubricants is described in relation to the phenomenon of the "wringing" together or "striction" of surfaces at light pressures, especially with indifferent lubricants, when film rupture occurs early during the thinning of the film. The latent period, observed and first described by Hardy, during which friction changes occur, has been measured for several lubricants at low pressures. Explanations of hydraulic "striction" and the "latent period" are suggested.



Automatic Machine Reduces Heat Treating Time

Case hardening time for the inside surface of National Ideal pump cylinder liners up to 36 in. long and 8½ in. dia was reduced from more than 4 hr to only 4 min by this fully automatic electric induction heat treating machine. This ma-



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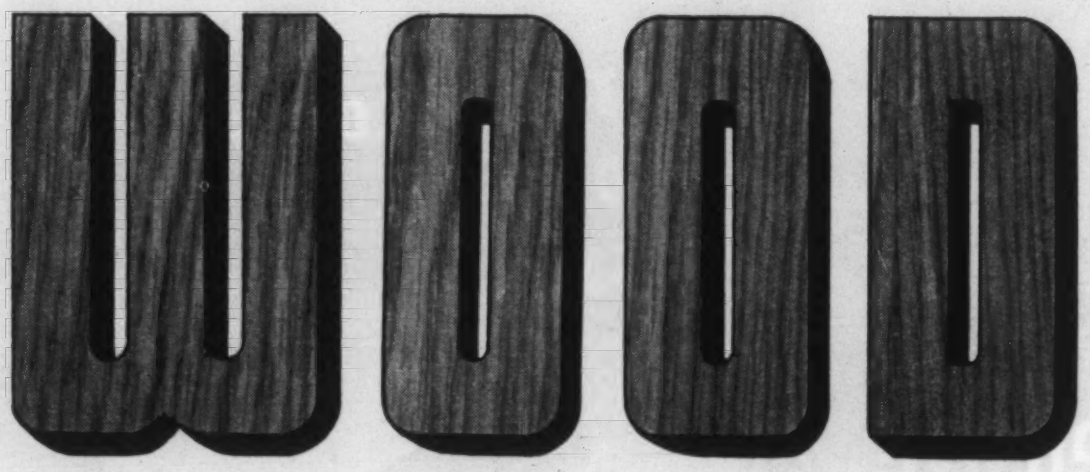
WELDING ELECTRODES • COMMERCIAL CHAINS • TIRE CHAINS

Among the gears, shafts, and fly wheels of industry are the many spools, spindles, rollers, knobs, and handles which make the machines complete. Time and again experience has proved that of all the materials available for these uses, first choice is



GAMBLE BROTHERS has long been a prime source for industrial turnings . . . rough, semi-machined, or finished . . . in solid or laminated hardwoods. Industrial users have learned from gratifying experience that they can safely rely on the accuracy and uniformity of the parts GAMBLE BROTHERS produces, and on the thorough seasoning and careful selection of the wood stock from which they are made.

More than merely a woodworking plant, GAMBLE BROTHERS has earned nationwide recognition as wood engineers. If there is any question as to how wood can solve your design or production problems, accept the assistance of GAMBLE BROTHERS' more than fifty years' experience in wood engineering. No obligation.

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INCORPORATED

News Digest

chine, one of the largest of its type in the United States, is in the production line of the Toledo, Ohio, plant of The National Supply Co., the world's largest manufacturer and distributor of oil field equipment and machinery. Liners are used in slush pumps which circulate mud to the drill bit.

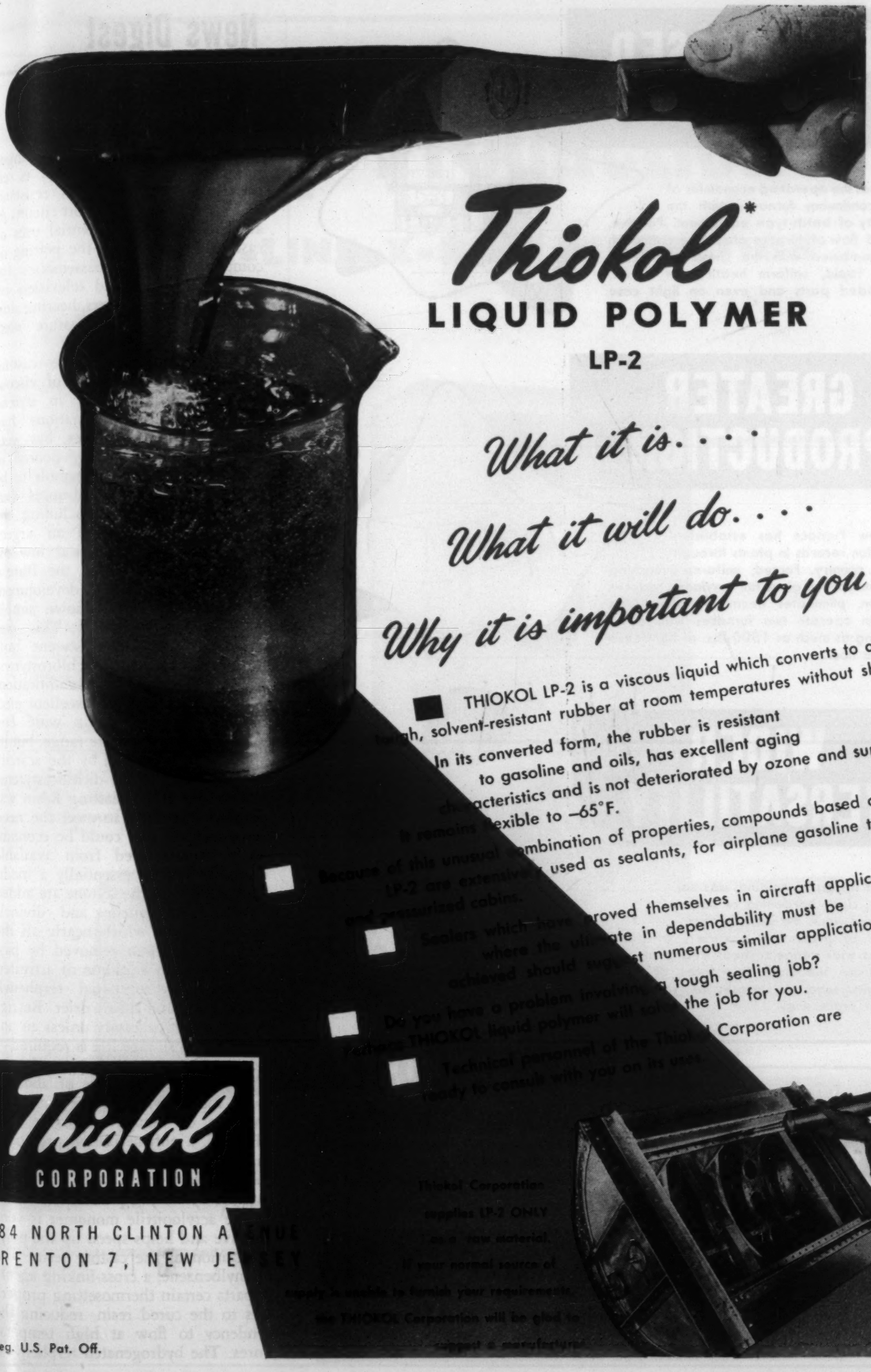
Surface hardenss, depth of case, and grain structure are held within close limits by automatic controls of temperatures and timing, which are set by the operator. Another important advantage of the improved method is that liners come out of the machine without scale and are hardened only on the inside surface. This leaves a tough, shock-absorbing structure in the surrounding metal with an easily machinable outside surface.

A water quenching spray head follows the heat head through the liner and continues to operate for a short period after the power goes off, thus cooling liners enough to be removed manually.

New Casting Resin for Embedding Electronic Assemblies

A new casting resin for embedding or potting electronic components and assemblies has been developed by Max M. Lee and associates of the National Bureau of Standards' Ordnance Development Div. Easily manufactured at low cost from available raw materials, the resin has good storage properties even without refrigeration. Its physical properties and electrical characteristics at both high and low frequencies are in general as good as those of expensive-to-make and hard-to-store casting resins. Designated NBS AN-5 Casting Resin, its unique ingredient is a small quantity of acrylonitrile monomer.

Casting resins are applied by pouring them in liquid form into molds containing the electronic assemblies to be embedded. Polymerization of the resin is then induced, causing it to harden. The resin hermetically seals the assembly, protecting it from



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LP-2

What it is. . . .

What it will do. . . .

Why it is important to you . . .

■ THIOKOL LP-2 is a viscous liquid which converts to a tough, solvent-resistant rubber at room temperatures without shrinkage.

■ In its converted form, the rubber is resistant to gasoline and oils, has excellent aging characteristics and is not deteriorated by ozone and sunlight. It remains flexible to –65°F.

■ Because of this unusual combination of properties, compounds based on LP-2 are extensively used as sealants, for airplane gasoline tanks and pressurized cabins.

■ Sealers which have proved themselves in aircraft applications where the ultimate in dependability must be achieved should suggest numerous similar applications.

■ Do you have a problem involving a tough sealing job? Perhaps THIOKOL liquid polymer will solve the job for you.

■ Technical personnel of the Thiokol Corporation are ready to consult with you on its uses.

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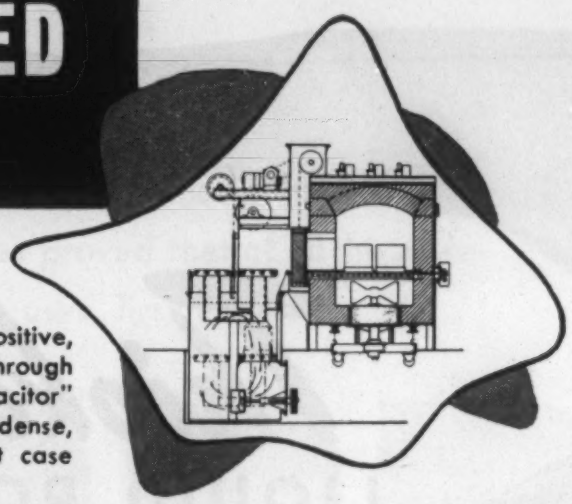
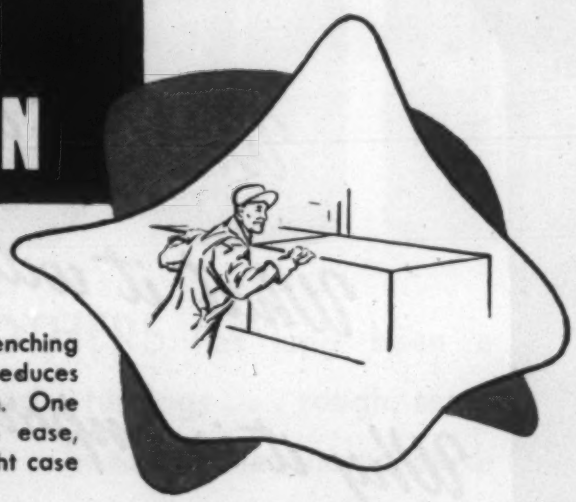


Combines the operating economies of large continuous furnaces with the flexibility of batch-type equipment. Positive, directed flow of furnace atmosphere through load, combined with the "heat capacitor" assures rapid, uniform heating on dense, bulk-loaded parts and even on light case work.

GREATER PRODUCTION



The Dow Furnace has established production records in plants throughout the country. Forced, uniform quenching from atmosphere gives full hardness, reduces distortion, eliminates decarburization. One man can operate *two* furnaces with ease, producing as much as 1500-lbs. of light case work per hour.

WIDER VERSATILITY

Whether it's gas cyaniding, gas carburizing, clean hardening or carbon restoration work, the Dow Furnace is capable of processing a variety of parts having a wide range of heat treatments. To demonstrate the close tolerances of heat treatments, send us samples of your own parts for processing.

AT LOWER COSTS

Reductions in direct labor, material handling, machining and cleaning costs, coupled with improved quality, have resulted in savings amortizing the original cost of the Dow Furnace in a few months. Gas cyanides for ¼ to ⅓ the cost of liquid cyaniding.

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moisture, corrosion and fungus growth. The potted assembly is relatively rugged and shock resistant, and the possibility of short circuits or arcing is reduced. Potential uses of casting resins include the potting of components and subassemblies for radar sets, radio and television receivers and transmitters, hearing aids, and numerous subminiature electronic devices.

The first polymerizable casting resins generally consisted of viscous solutions of polystyrene in styrene monomer. Such preparations had many desirable properties, but were slow to cure after being poured in liquid form over the assembly to be embedded. Electronic advances during World War II, including the proximity fuze, created an urgent need for a more practical low-loss casting resin. Work by the Bureau at that time led to the development of what came to be known simply as NBS casting resin. This was basically a substituted styrene casting resin in which 2,5-dichlorostyrene was used to promote solidification. NBS casting resin has excellent electrical properties over a wide frequency and temperature range, but its application is limited by the scarcity and high cost of 2,5-dichlorostyrene.

The new AN-5 Casting Resin was developed at NBS to meet the need for a material that could be economically manufactured from available ingredients. It is essentially a modified styrene. To the styrene are added distilled acrylonitrile and divinylbenzene (from which nearly all the inhibitor has been removed by passing it through a column of activated alumina), hydrogenated terphenyl, polystyrene, and cobalt drier. Refrigeration is not necessary unless an unusually long storage life is required—storage in a cool, dark place (about 60 F) gives a shelf-life of about 8 to 18 months. Just before use, small amounts of benzoyl peroxide and "Pro-A", a polymerization promoter, that can be made available should the demand exist, are added to catalyze the curing process.

The acrylonitrile monomer is very reactive and helps speed up the polymerization of the casting resin. The divinylbenzene, a cross-linking agent, imparts certain thermosetting properties to the cured resin, reducing the tendency to flow at high temperatures. The hydrogenated terphenyl is

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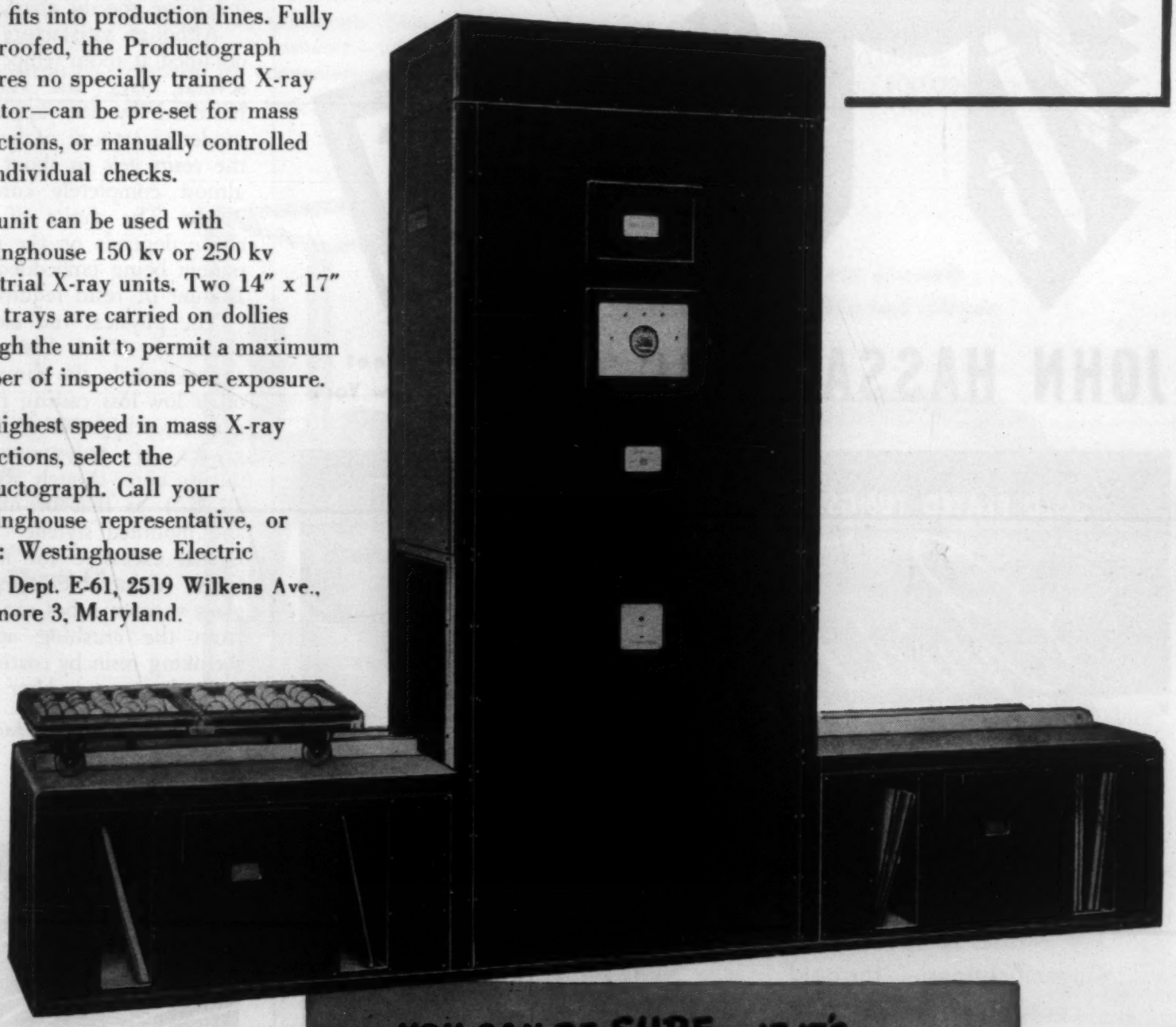
For highest speed in mass X-ray inspections, select the Productograph. Call your Westinghouse representative, or write: Westinghouse Electric Corp., Dept. E-61, 2519 Wilkens Ave., Baltimore 3, Maryland.



J-08

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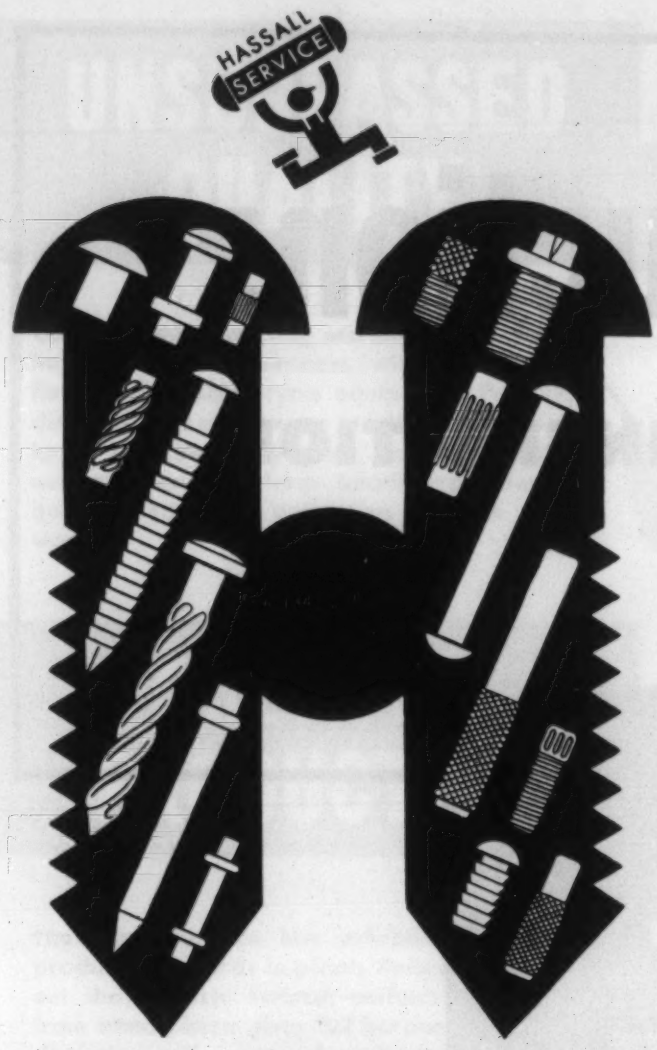

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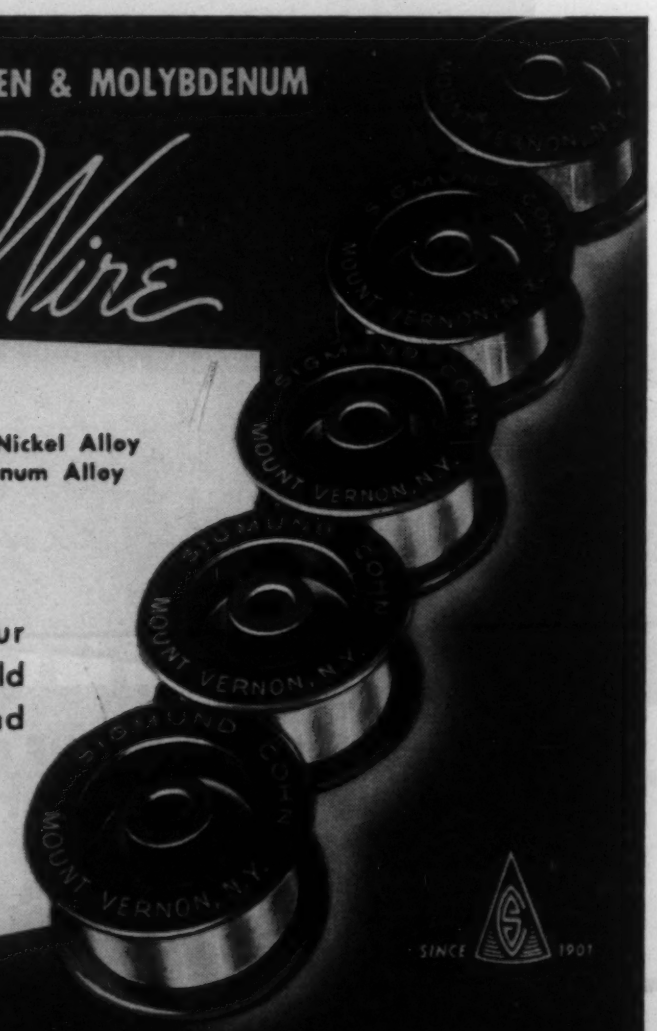

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added to improve the impact resistance, and the polystyrene to improve the body, pouring consistency, and final mechanical properties; both of these inert ingredients also reduce shrinkage and absorb heat of polymerization. The small amount of cobalt drier counteracts the inhibiting effect of air on the surface of the casting resin during curing and results in a hard nontacky surface. The composition can be varied considerably when it is desired to maximize specific characteristics.

Although satisfactory cures can be obtained at room temperature within several days, the curing rate is hastened by the application of a moderate amount of heat. At 122 F the resin gels in about 2 hr, and is almost completely cured in about 20 hr. The choice of curing technique depends on the type of component being embedded and on the amount of resin required.

The physical and electrical properties of AN-5 Casting Resin are approximately the same as those of other low-loss casting resins, and in general compare favorably with some grades of polystyrene. Shrinkage during cure, though about the same (9.8%) as that of many polyester and modified styrene casting resins, is still excessive for many applications. Vulnerable components like glass vacuum tubes can be protected from the crushing action of the shrinking resin by coating them with foamed silicone rubber.

(More News on page 234)

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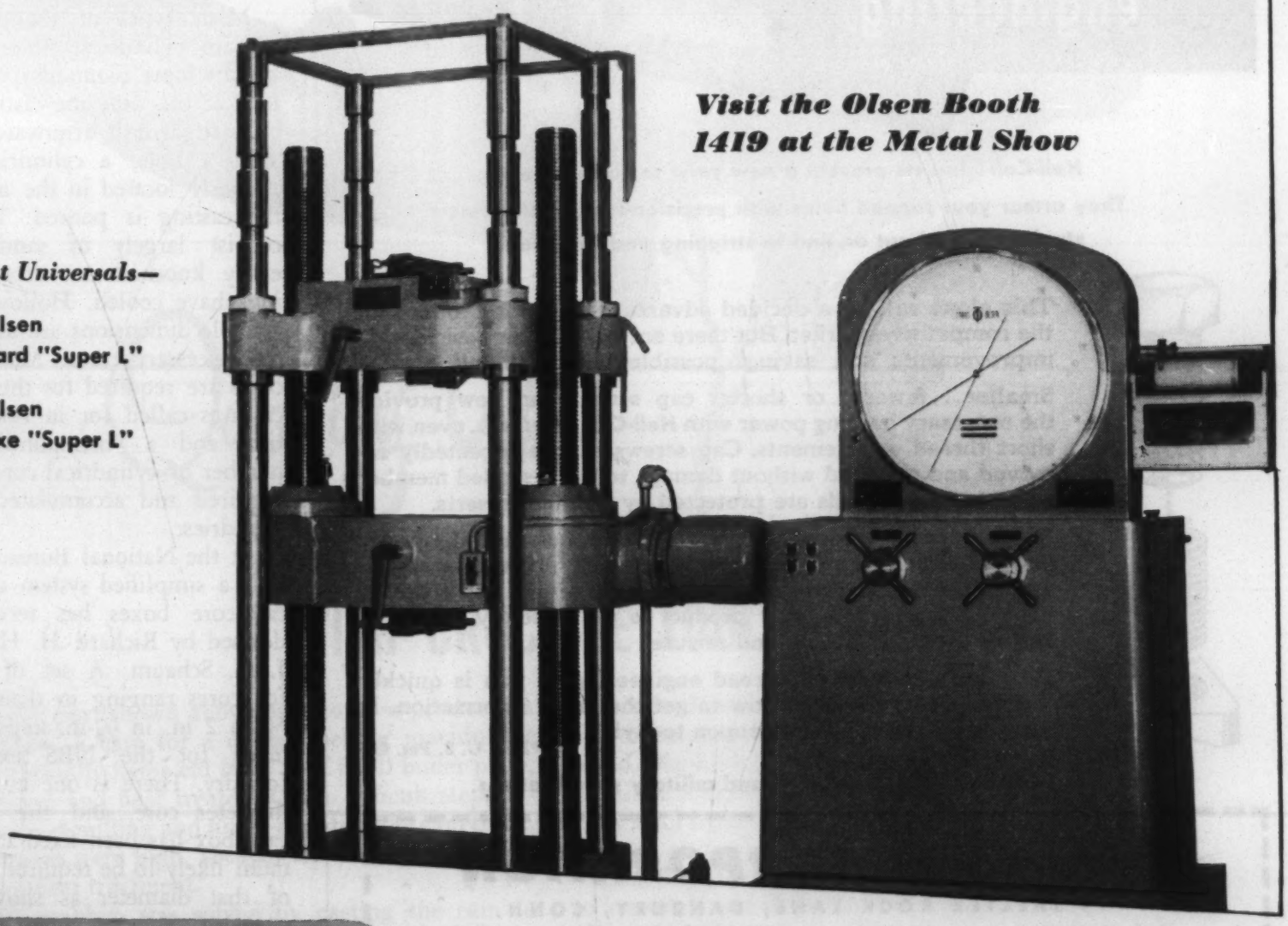

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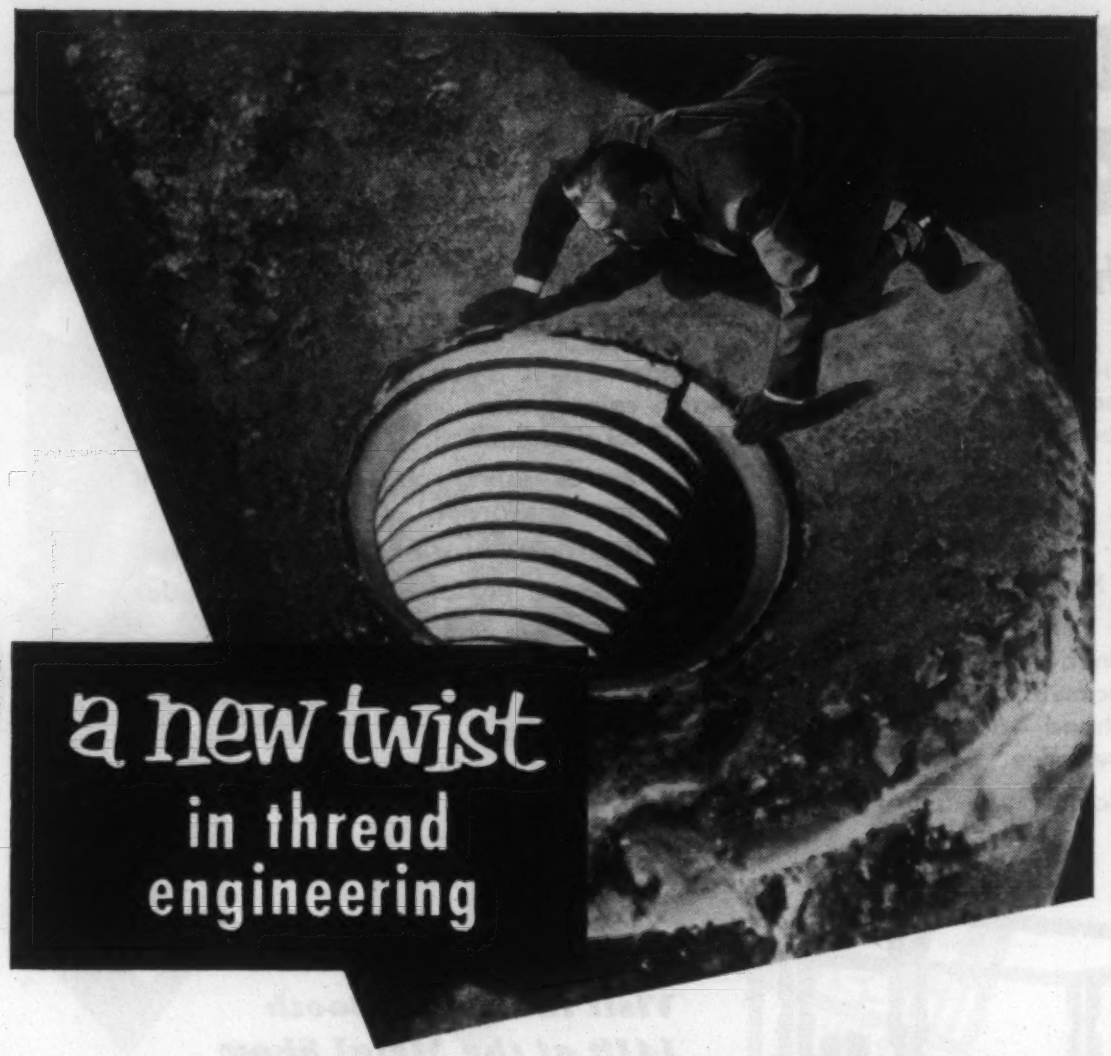
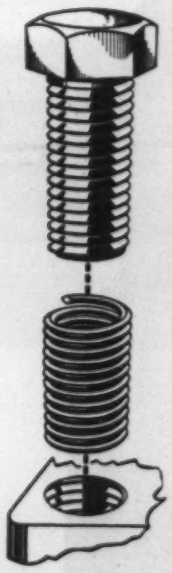


Heli-Coil* **Inserts present a new twist to screw threads. They armor your tapped holes with precision-formed stainless steel wire, and put an end to stripping and corrosion.**



This alone will be a decided advantage for your products in the competitive market. But there are still further basic design improvements and savings possible with *Heli-Coil* Inserts.

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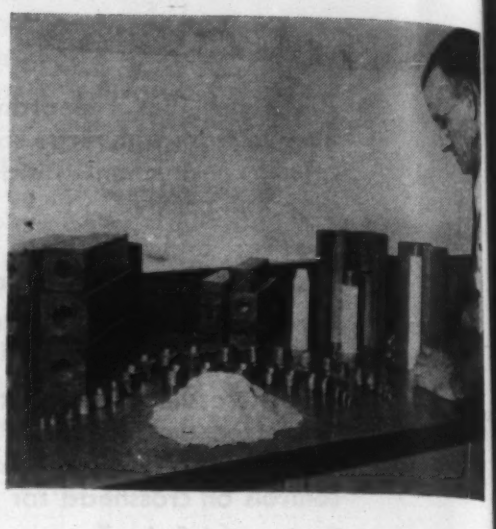
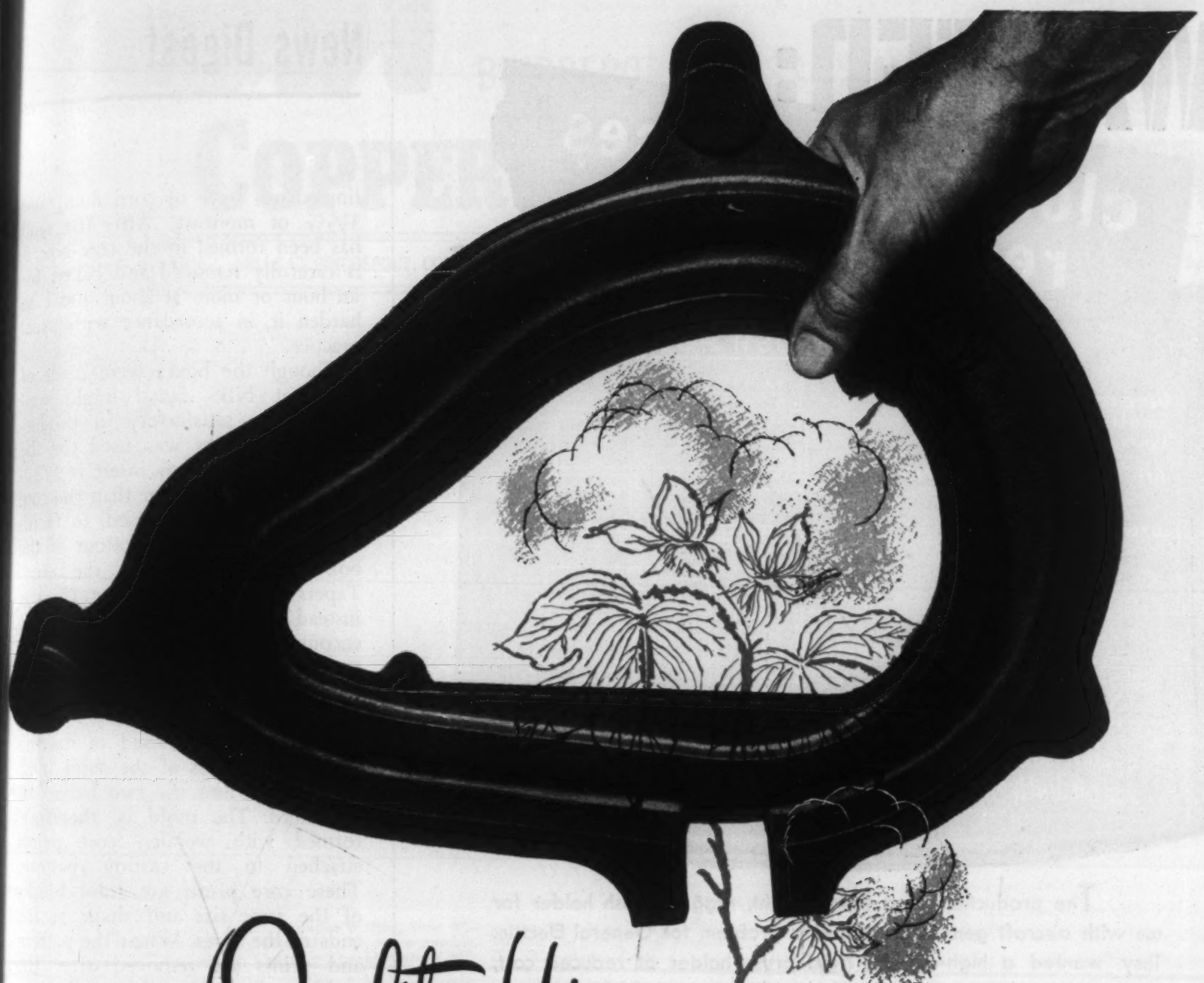


Versatile Core Boxes

Many types of foundry castings contain cylindrical holes, and it is usually more economical to form the hole at the time the casting is made than to drill it afterward. To form such a hole, a cylindrical core is properly located in the mold before the casting is poured. These cores consist largely of sand, and are easily knocked out after the castings have cooled. Hollow boxes of suitable dimensions are used to form the necessary cores. Many different cores are required for the variety of castings called for in foundry practice, and a correspondingly large number of cylindrical core boxes are acquired and accumulated by many foundries.

At the National Bureau of Standards a simplified system of cylindrical core boxes has recently been devised by Richard H. Harwell and J. H. Schaum. A set of 14 boxes for cores ranging in diameter from $\frac{3}{8}$ to 2 in. in $\frac{1}{8}$-in. steps, has been made for the NBS experimental foundry. There is one box for each diameter core, and the length of each box has been fixed at the maximum likely to be required for a core of that diameter as shown by experience. Shorter cores can be cut from full-length units, or can be made by placing cylindrical pieces of wood of the proper length in the core-box cavity. When a core with a tapered end is required, a brass insert having a standardized taper is placed in the core box.

The NBS core boxes are filled and rammed with conventional sand-and-binder mixtures. A typical mixture contains, in addition to washed silica sand, about $1\frac{1}{2}\%$ of



Quality Up, costs and rejects down WITH CRUCIBLE TOOL STEEL CASTINGS

The steel part shown above used to be a production headache. A cam for a cotton picking machine, it was originally flame cut from SAE 8730 boiler plate, machined and heat treated. Other difficult steps included end-milling and finish-grinding the cam track. Rejections were high, because the cam often warped during heat treatment.

The problem was solved by casting the cam in Airkool®, a Crucible air-hardening tool steel. When the customer receives the casting from Crucible, all he has to do is finish it, mill the cam track and heat treat. He doesn't have to finish grind — Airkool is non-deforming when properly hardened and tempered. Machining costs are way down and quality is up, since Airkool resists wear far better than the low alloy steel from which the part used to be made.

Crucible's casting facilities often make it possible to use wear- and abrasion-resisting tool steel for complicated machine parts. We may be able to help you just as we helped the cotton picking machine manufacturer. Get in touch with Crucible today!

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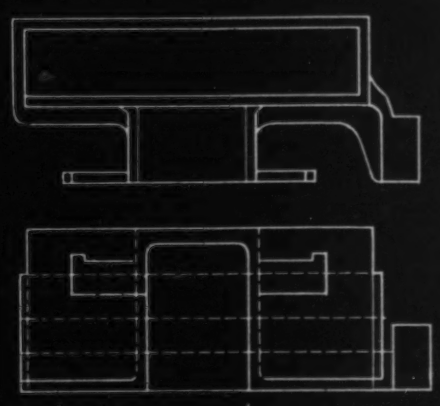
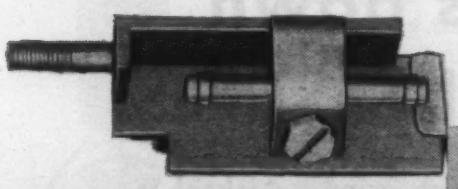


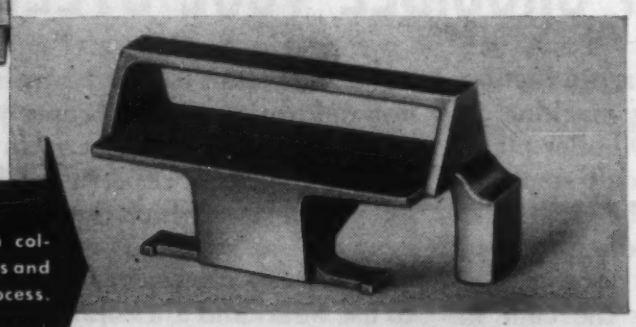
This design is the best from production standpoint
We could produce it to reflect credit
on both companies. E.B. Atlantic Casting

The production of a light weight, rugged brush holder for use with aircraft generators posed a problem for General Electric. They wanted a high-quality, rigid brush holder at reduced cost, produced by a process that afforded closer control of tolerances.

Atlantic was consulted and the recommendations they made on the brush holder design provided more than ample strength. The Atlantalloy process provided the close tolerances and lower cost.



Old brush holder designed by General Electric for use on aircraft generators.



New brush holder designed in collaboration with Atlantic engineers and produced by the Plaster Mold Process.

WRITE **for a copy of "Quality Precision Castings for Industry" on your Company letterhead. This booklet explains how the plaster mold process cuts production costs, and includes specifications on Atlantic's alloys.**

CASTING and ENGINEERING CORP.

News Digest

linseed oil, 1/2% of corn flour, and 3 1/2% of moisture. After the sand has been formed in the core box, it is carefully removed and baked for an hour or more at about 400 F to harden it, in accordance with usual practice.

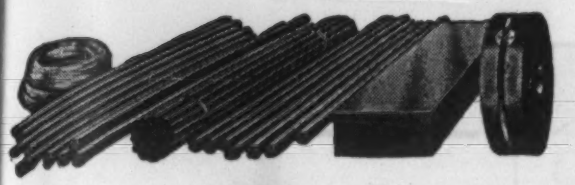
Though the boxes were made of wood at NBS, metal might well prove more satisfactory in production work. Brass was used for the tapered inserts. Each insert is 1/32-in. smaller in diameter than the core box with which it is used, to facilitate placing it at the bottom of the box prior to ramming the sand. Tapers were standardized at 15 deg, instead of the wide variety of tapers encountered in common practice. A standard vertical length for the tapered insert was also adopted for each core diameter.

When cores are used in making castings, the ends of the cores must fit properly into the two halves of the mold. The mold is, therefore, formed with wooden core prints attached to the casting pattern. These core prints are solid blocks of the same size and shape as the ends of the cores. When the pattern and prints are removed after the mold has been formed around them, the mold is left with holes of proper diameter, depth and taper to accept the ends of the cores. Because taper and length of the core ends are standardized in the NBS system, it becomes possible to use a master set of core prints, which further simplifies foundry operation.

The 14 versatile NBS core boxes take care of the great majority of core requirements at the NBS experimental foundry, largely eliminating the need for making special boxes for new jobs. Foundry operation is thus simplified and made more economical. Because of its inherent advantages, other foundries may find the NBS system useful, with or without modification.

World's Largest Salt Bath

The world's largest neutral salt bath operating at 2350 F was recently installed in the Air Force Experimental Plant located at Adrian,



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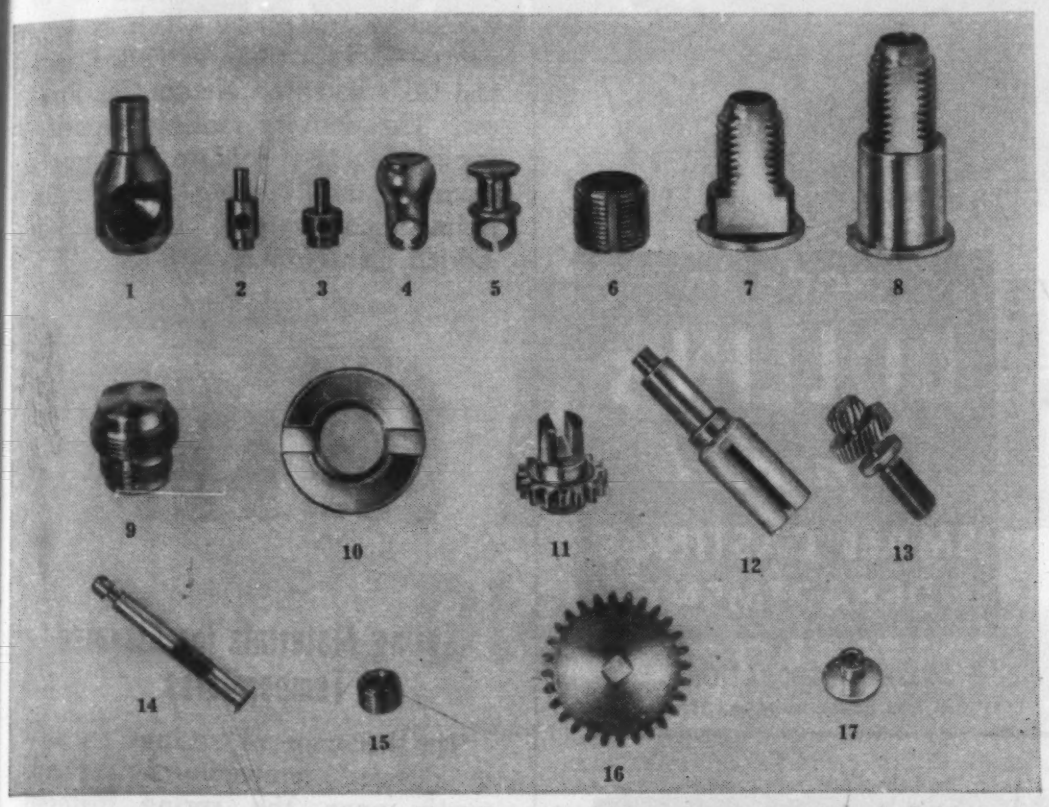

Screw machine items which required milling, side drilling, slotting, broaching or flaring operations were completely finished on t'e screw machine without the necessity of "secondary" operations. Courtesy The Mattatuck Mfg. Co., Waterbury, Conn.

Complete Screw Machine Operation

...including milling, slotting, broaching, cross drilling

Ingenuity, coupled with existing know-how, can often incorporate costly so-called "secondary" operations such as milling, side drilling, slotting, broaching, spinning, flaring, etc., as a complete screw machine operation.

Aside from substantial cost savings, advantages are:

1. Space and labor savings, since no additional machines and operators are needed.
2. Time saving – because some of the "secondary" operations are performed simultaneously with the preparation of the blank.
3. Economical – because the complete job leaves the machine with no parts in unfinished stages subject to possible spoilage or loss.

Since machine setup time takes considerably longer because of special chucks, holding fixtures, timing cams, etc., complete screw machine operation usually is justified on long runs.

Cross Drilling

Samples 2 and 3 were cross drilled while the machine prepared the blanks, the pick-up arm removing the finished blanks from the spindles and transferring them to the position where the cross drilling operations were performed. Sample 1 is partially cross drilled; samples 2 and 3 are cross drilled and chamferred on both sides of the hole; sample 4 was cross drilled from a side slide, then picked up and slotted to complete the piece; and sample 5 was cross drilled on a stopped spindle, then milled from the turret to make the front section complete.

Milling

Sample 6 illustrates side milling performed after the pick-up arm removes the blank and sets it into position for the milling operation.

Nos. 7 and 8 illustrate flat milling on a stopped spindle—with the milling saw installed in a fixture on the turret.

No. 9 illustrates straddle milling. Here the transfer arm picks up and holds the piece while the two saws mounted on the slotting arbor perform the straddle milling. No. 10 illustrates section milling which is performed with the help of a special twin-milling cutter head mounted in the transfer station.

Cross Slotting

No. 11 illustrates slotting on the end with a stopped spindle, the movable saw being mounted on the cross slide to accomplish a flat bottom on the milled slot. On sample No. 12, the saw was on the turret, and after one slot was cut, the saw was indexed 90° and the second slot was cut. No. 13 illustrates a slot through the threaded end. A wedge-shaped tool followed up the saw and expanded the slot for spring action in the threaded portion.

Flaring, Broaching, Shearing

Sample No. 14 was end flared or expanded by a spinning tool mounted in the turret. Nos. 15 and 16 illustrate broaching operations which were performed with the piece in the spindle prior to cutoff. No. 17 illustrates a combination shearing and forming operation which was performed on the screw machine by using a punch in a turret station.

Statistical Quality Control

To meet the tight tolerance specifications called for on items used for defense production, it is almost necessary to have the Inspection Department utilize "Statistical Quality Control." For example, five samples taken at random from each machine are carefully gauged and the results are plotted on special cross-sectioned paper, which give average and range of the specific measurements on the vertical axis and the time element on the horizontal axis. The position which these points take indicates the rapidity of tool wear, the need for tool adjustments, tool sharpening, or possibly, a change to a higher grade of tool stock such as tungsten-carbide.

With few exceptions, the parts illustrated were made from Ledrite 6, free cutting brass rod, which contains approximately 61% copper, lead 3.4% and zinc remainder. It has a machinability rating of 100 per cent and is the most widely used alloy. For specific information on rod alloys write for "Technical Handbook." (8814)

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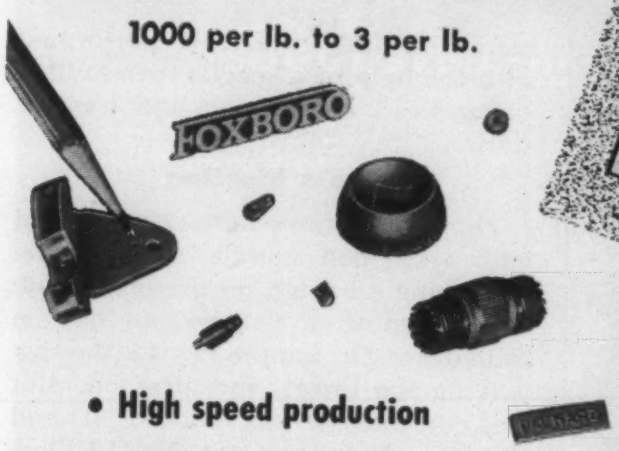

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News Digest

Mich. It is used for heating steel billets for press forging. It is 20 ft long, 10 ft deep and 4 ft wide, and is an electric furnace of 5,000 kilowatt capacity.

This bath holds 128,000 lb of molten neutral salt, which is kept neutral by four units of Park Chemical Co.'s patented Neutra-Gas Process. The delivery tanks for purifying gas are 12 ft long to give proper scouring and cleaning action. The Bohn Aluminum Co. operates this Adrian plant for the Air Force.

Spring Materials for Elevated Temperatures

The behavior of springs stressed at elevated temperatures depends mostly upon the spring material used, according to an article in the August issue of *The Mainspring*, published by the Associated Spring Corp. For this kind of service the most important consideration is the analysis of the spring material. The fabrication and processing of the material into springs is important, but the choice of material itself automatically sets up the limitations as to what temperatures the spring may satisfactorily function at.

The most important consideration for springs in use at elevated temperatures is generally their ability to carry certain loads and maintain them at the operating temperatures without undergoing permanent deformation or set. Then, in testing spring materials for such conditions, test springs are made and tested under varying temperatures and various stresses. The per cent load loss in 72 hr at stress and temperature is used as an indication of the value of the spring material for such service. Tests have shown that for steels, substantially all load loss occurs in this length of time. For certain nonferrous materials this is not true.

The article considers the commonly used spring materials and the temperatures at which they can be

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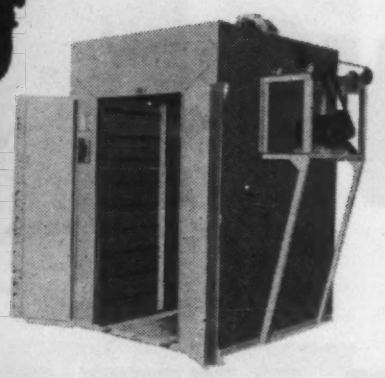
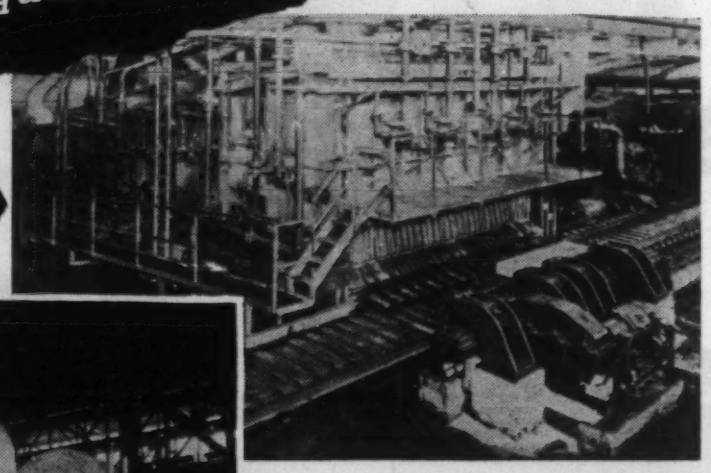
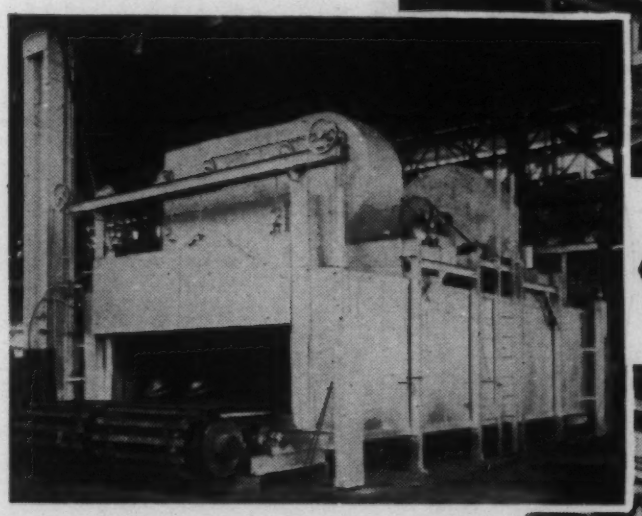


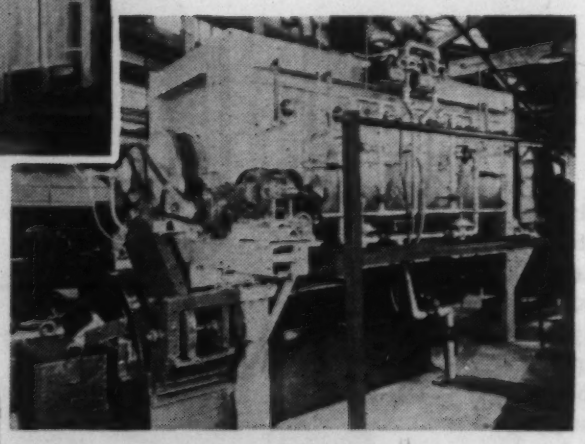
Standard batch type ovens; gas, oil or electric; in many sizes for heat treating, baking or drying.



Pusher type furnace for heating billets, bars and cakes.



Continuous conveyor oven for aluminum and magnesium billets and extrusions.



Revolving retort furnace for annealing, hardening and drawing stampings, springs, cartridge cases, small parts, etc.

Learn how Rockwell furnaces, ovens, air heaters; quenching, cooling, dipping, pickling, descaling and cleaning machines; strip mill equipment and materials handling equipment are serving American industries for defense—and for peace. Write for Catalog today.

W. S. ROCKWELL COMPANY
208 ELIOT STREET • FAIRFIELD, CONN.

News Digest

satisfactorily used with a load loss of perhaps not more than 5%. First, the cold-drawn spring steels, such as hard-drawn MB wire, are not generally considered. Oil-tempered spring wire, of which the carbon steel valve spring wire SAE 1070 is a selected grade, is quite generally satisfactory up to 300 F. Music wire is not quite as good at 300 F as the carbon steel valve spring wire. Nickel alloys are also a material to be considered.

Chromium-vanadium steel, SAE 6150, is slightly superior to oil-tempered carbon steel, and it could be used at temperatures up to 350 F. Chromium-silicon steel, SAE 9254, is usable up to 450 F. Type 302, 18 chromium-8 nickel stainless steel has been in use for elevated temperature service for some time.

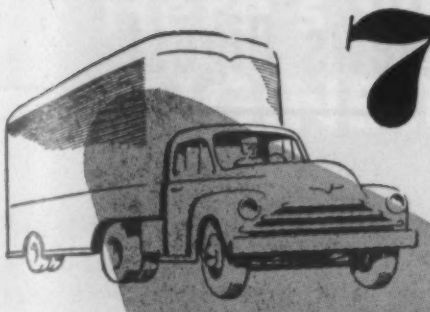
It would appear that this material would be satisfactory up to 550 F. A good, if not the best spring material for elevated temperature use is 18-4-1 high-speed steel. Even this is not very satisfactory above 700 F.

There are also a few springs which, besides not losing load at elevated temperatures due to spring set, must also not lose load due to modulus changes of the material. The modulus in torsion of most materials decreases as the temperature increases. For such springs a spring material with a constant or nearly constant modulus must be used. Probably the most generally used spring material for such springs is an Invar type alloy called Ni-Span-C. High-speed steel is also very good for these springs because, while its modulus is not constant, it does not decrease rapidly with increasing temperature.

Plastics Found Useful for Ship and Aircraft Models

The Navy Dept. David Taylor Model Basin in Washington is experimenting with the use of laminated glass cloth and plastics for its ship and aircraft models.

Since 1900, sugar pine, mahogany



7 Truckloads

TO FILL THE...

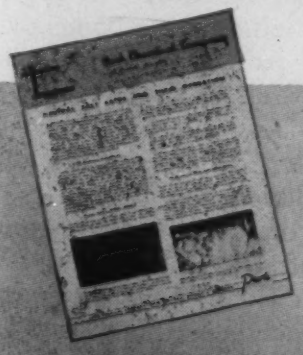
Heat Treating Installation at Bohn Aluminum Corp., Plant 24, Adrian, Mich.

...WORLD'S LARGEST NEUTRAL SALT BATH!

Here is the world's largest neutral salt bath operating over 2000°F. It is used for heating steel billets for press forging. It operates at 2350°F. and holds 128,000 lbs. of molten Park Chemical neutral salt. It is 20 feet long, 10 feet deep and 4 feet wide and is an electric furnace of 5,000 Kilowatt capacity.

The salt is kept neutral by Park's patented (U. S. Patent No. 2474680) Neutra-Gas Process, a simple, efficient, economical method of maintaining absolute neutrality in chloride-base salt baths. Suitable for use from 1350°F. to 2500°F. This patented process completely eliminates objectionable oxides simply by periodically passing a harmless gas through the molten salt.

No rectifiers are required . . . sludging is eliminated . . . and no fresh salt additions are needed except to replace drag-out. Further, the process maintains original fluidity of the bath and work leaves as clean as when it entered.



For specific application recommendations on Park's Neutra-Gas Process, consult your nearest Park service representative or write for Park's new Technical Bulletin No. H-1.

Park
CHEMICAL COMPANY
8079 Military Ave., Detroit 4, Mich.

MEASURE IN MICROINCHES RMS

Disc Production
***increased over* 100%**

because THE S. K. WELLMAN CO.
uses the PROFILOMETER

The S. K. Wellman Company of Cleveland, Ohio, world's largest manufacturer of all-metal clutch facings and brake linings, was experiencing trouble in the manufacture of a special clutch disc for use in a vital aircraft production unit.

Specifications for this special clutch disc called for its manufacture to be exceedingly thin and with a surface finish of no more than 32 microinches r.m.s. When the thin clutch discs were first put into production, Wellman experienced warping, burning and glazing during grinding and lapping. Production was low and scrappage was excessive. Some method, Wellman decided, was needed to increase production yet maintain specified tolerances.

Then Wellman turned to the reliance of the Profilometer.

With the Profilometer, Wellman production men found they were grinding and lapping the thin clutch discs far too smoothly—from six to ten microinches—thus causing the disastrous warping and burning. It was also found with the Profilometer that grinding and lapping time of the discs could be cut to a minimum due to accurate on-the-job surface measurement. Surface finish was held to the specified 32 microinches. And most important of all—scrappage was almost entirely eliminated and production increased over 100%.

This is just another example of the ever increasing use of the Profilometer as an important *shop instrument.*

To learn how the Profilometer can help cut costs in your production, write today for these free bulletins.

Profilometer is a registered trade name.

MICROMETRICAL
MANUFACTURING COMPANY
formerly PHYSICISTS RESEARCH COMPANY
Instrument Manufacturers
ANN ARBOR 14 • MICHIGAN

News Digest

or balsa wood have been used for these models because they seemed to be the only materials which would not soften or distort during the hot, humid weather encountered in Washington summers. European model basins have used wax for ship model construction almost entirely, because it was cheaper, easier to work, and their summers are usually cooler and less humid. With the recent development of synthetic waxes, it was considered probable that a wax composition could be developed which would stand the high temperatures without distortion, and be strong enough to permit the installation of complicated appendages required on present-day models.

Considerable research and experimentation have been conducted at the Taylor Model Basin along this line since 1948, and a wax and plastic composition has been found which is useful for some types of ship models. Because of the heavy weight of wax, it cannot be used on some shallow draft ship models.

The great strides made in the field of plastics and glass cloth offer another media for model making, so the Taylor Model Basin is exploring the possibilities and applications of these materials. Several models have been made and tested in wind tunnels and model basins. The following advantages of plastic models over wood or paraffin models have been discovered. The models are lighter and very easy to handle, yet they are as strong, and in some instances, stronger, than other types. This is especially desirable in high velocity wind tunnel tests. More room is left inside the model for instruments as the shell is much thinner than in either wood or wax models. Plastic models can be ballasted much more accurately than other kinds. Color can be added to the plastic, thereby eliminating one or more coats of paint. The plastic coloring will not dull or fade. Plastic models pick up less moisture from the air and water, so they retain their accurate dimensions longer.

It is often desirable to modify a model after it has been tested. These models can easily be altered by altering the original pattern and mold, removing the section from the model that is to be altered, placing the

Case History MM-102

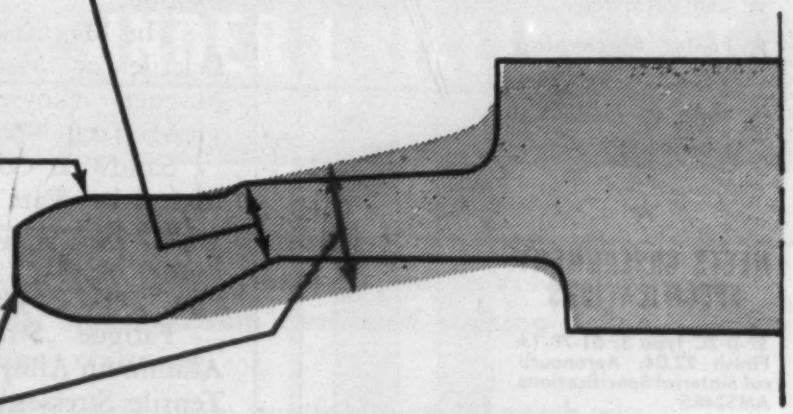
Here's what we mean by *SUPERIOR* ENGINEERED FOUNDRY PRODUCTS...

PROBLEM:

1. Conventional design of cast steel sprocket blank impaired proper directional solidification of the metal, causing uncontrolled shrinkage in the outer rim.
2. Assurance of delivery of sound castings was possible only through expensive non-destructive inspection of each blank.
3. Casting and machining losses were excessive.

OUR SOLUTION:

FOUNDRY ENGINEERED DESIGN to establish a relationship of tooth, web and hub sections which would insure uniform directional solidification of the metal, place metal where needed most and minimize necessity for expensive inspection of each part.



RESULT: 17.6% SAVINGS

1. Elimination of shrink holes in outer rim through proper directional solidification of the metal.
2. Elimination of need for expensive inspection of each part.
3. Reduced casting and machining costs.

BLACK LINES . . . . ORIGINAL DESIGN
RED LINES . . . . . MODIFIED DESIGN

TOTAL COST OF PART REDUCED 17.6%

YOU TOO CAN GET SAVINGS LIKE THIS! CONSULT OUR PRODUCT DEVELOPMENT SECTION REGARDING YOUR PROBLEM . . . WHILE IT'S STILL ON THE DRAWING BOARD!

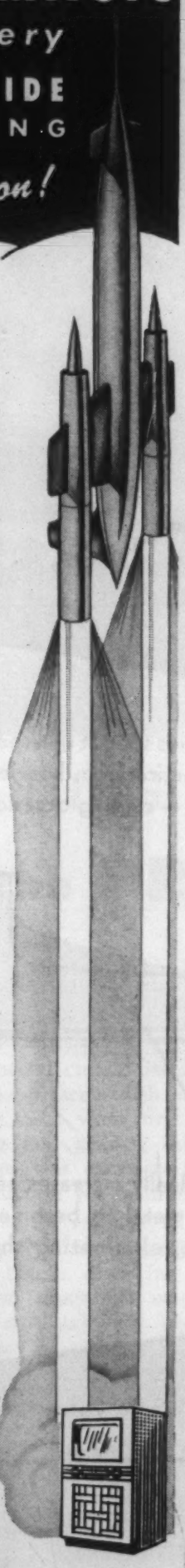
ENGINEERED FOUNDRY PRODUCTS
Since 1916

LET OUR FOUNDRY ENGINEERS HELP YOU CONSERVE CRITICAL MATERIALS

SUPERIOR STEEL AND MALLEABLE CASTINGS CO.

BENTON HARBOR, MICHIGAN, U. S. A.

BLACK MAGIC
meets every
BLACK OXIDE
FINISHING
Specification!



BLACK MAGIC — whether applied to civilian or defense production — has proved to be a versatile, economical finish. Its ability to blacken heat treated parts or previously "hard to blacken" items has established **BLACK MAGIC** as a finish capable of exceeding black oxide requirements.

Other advantages are:

- ★ One Bath—One Salt
- ★ Lower Operating Temperature
- ★ Self Rectifying
- ★ Faster Blackening Cycle
- ★ More Corrosion Resistant

★

MEETS GOVERNMENT SPECIFICATIONS

57-0-2C type 3; 51-70-1A Finish 22.04; Aeronautical Material Specifications AMS2485

★

A comprehensive study of the application of a black oxide finish has been compiled and is now available in our latest catalog. Write for your complimentary copy today.

MITCHELL-BRADFORD CHEMICAL CO.
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Mitchell-Bradford
QUALITY PRODUCTS OF CHEMICAL RESEARCH

News Digest

model in the altered mold and adding the new section. When a number of identical models are required, a great saving in the cost of each model can be made because the mold and pattern can be used many times.

NACA Publishes Research Reports

The National Advisory Committee for Aeronautics recently published several reports on research of interest to materials engineers. These reports are available from the NACA, 1724 F St., Washington 25, D. C. Code number, title and author must be given with all requests. The reports include:

"The Magnetic Properties of Some Ductile or Machinable Permanent Magnet Alloys." E. C. Railton. (RAE Tech Note EL 29) N-14703.

"Sandwich Construction and Core Materials. Part V." W. J. Pullen (ARC R & M 2686; ARC 10,501. Formerly ARC 9017; Strut 938; Plas. 57) N-14407.

"Fatigue Strengths of 14S-T4 Aluminum Alloy Subjected to Biaxial Tensile Stresses." Joseph Marin and W. P. Hughes, Pennsylvania State College. NACA TN 2704.

"Velocity of Action of Oxygen, Hydrogen Sulfide, and Halogens on Metals." G. Tammann and W. Koster. NACA TM 1339. Trans. from *Zeitschrift fur Anorganische und Allgemeine Chemie*, V. 123, Aug. 1922.

The Oxidation of Metals and Alloys. Erich Scheil. NACA TM 1338. Trans. from *Zeitschrift fur Metallkunde*, July 1937.

"Influence of Structure on Properties of Sintered Chromium Carbide." H. J. Hamjian and W. G. Lidman. NACA TN 2731.

"Effect of Temperatures from -70 to 600 F on Strength of Adhesive-Bonded Lap Shear Specimens of Clad 24S-T3 Aluminum Alloy and of Cotton and Glass-Fabric Plastic Laminates." H. W. Eickner, W. Z. Olson and R. F. Blomquist. NACA TN 2717.

(Continued on page 247)

Just one example

stainless steel 18-8
weight ½ lb.

of how everyday, we are called upon to apply precision investment casting to solve difficult machining problems—such as the part illustrated above. All milling operations on this piece were eliminated by changing to investment casting.

FEATURES

- Alloy tool steels and any other metals may be cast.
- Economical to produce even in comparatively small quantities.
- Tolerances to general machine shop practice (plus or minus .005" on decimal dimensions and 1/64" on fractional).

Write for our newly prepared 8-page brochure that illustrates the variety of investment castings possible to produce, and processes involved—so you can judge their adaptability to your use in future production planning.

EpCo
ENGINEERED
PRECISION CASTING CO.
STATE H'WAY No. 4 A
MORGANVILLE, NEW JERSEY

News Digest

"Investigation of Statistical Nature of Fatigue Properties." E. Epremian and R. F. Mehl. NACA TN 2719.

"Effect of Open Circular Holes on Tensile Strength and Elongation of Sheet Specimens of a Magnesium Alloy." R. S. Barker, Aluminum Co. of America. NACA TN 2716.

Government Research Reports Offered

Technical advances in ceramics and metals are described in a group of government research reports now available. Abstracts of the reports follow:

"Development and Application of Barium Titanate Ceramics as Non-Linear Circuit Elements: Final Report: Glenco Corp." Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm, $2.75. Enlargement Print, $8.75. Treats barium titanate electrical and dielectric properties; barium compounds; and electronic circuits and elements. No PB 106299.

"Large Forgings in Germany. Lecture Delivered at Light Metals Forging Symposium, Wyman-Gordon Co., Worcester, Mass., Hubert Altwicker: U. S. Air Materiel Command." Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm, $2.00. Photostat, $3.75. Treats: Steel forgings—physical properties—Germany; forgings—fabrication—Germany; aluminum—copper alloys—forging—Germany; aluminum-magnesium-zinc alloys—forging—Germany; magnesium alloys—forging—Germany. No PB 106984.

"Investment Precision Casting: U. S. Office of Technical Services." Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Mimeograph, 25¢. Treats: Lost-wax process; cobalt alloys—casting; casting, precision. No. PB 111001.

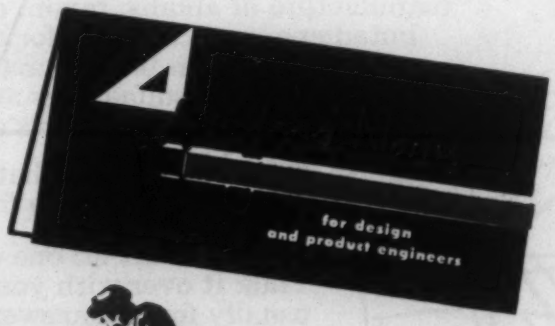
"Light Metal Castings, Miscellaneous Papers: Germany, Reichsluftfahrtministerium." (Text in German) Available from Library of Congress, Photoduplication Section,

Cooking surfaces have greater sales appeal when finished with Velvaglaze. The hard, dense Velvaglaze finish resists staining from continued cooking action and frequent cleaning.

Velvaglaze is exclusively available on Monarch aluminum Permanent Mold and aluminum Diecastings. It is one of the complete range of finishing methods available on Monarch castings. Velvaglaze cuts finishing costs and improves product quality.

WRITE FOR THE VELVAGLAZE STORY "GOOD NEWS"

It could provide the answers to many of your finishing problems.

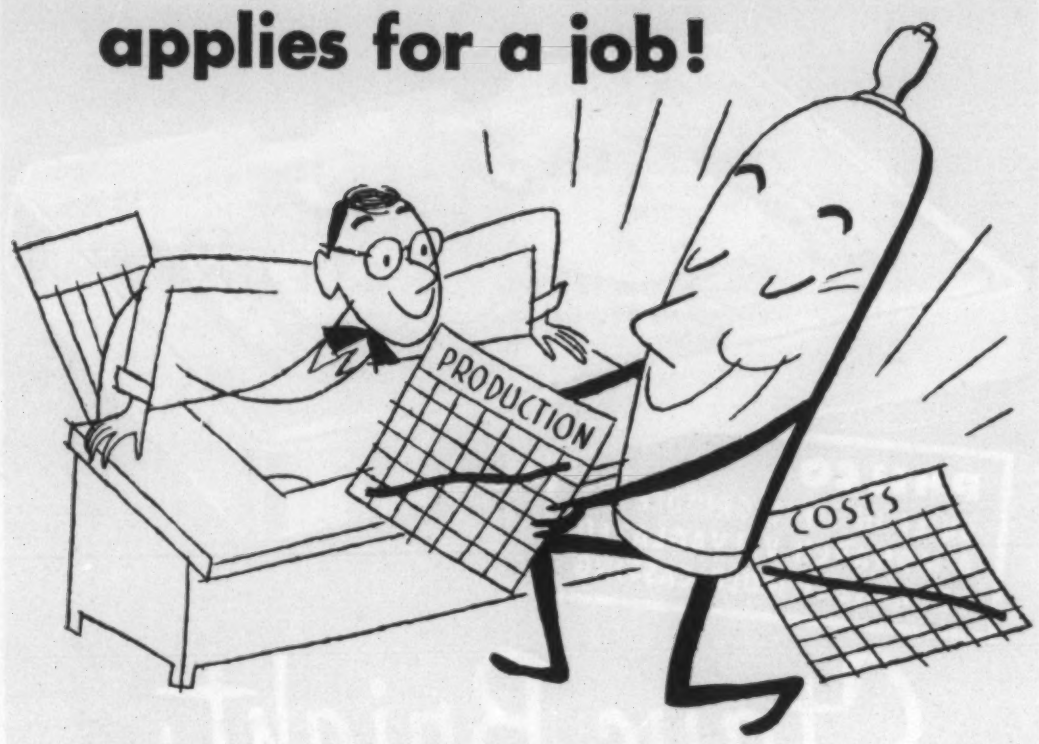


- *Aluminum Permanent Mold*
- *Aluminum Die Castings*
- *Certified Zinc Die Castings*
- *Complete Product Assembly*
- *Every Modern Finishing Service*

Detroit Ave. at W. 93rd St., Cleveland 2, Ohio

Amazing Ammonia

applies for a job!

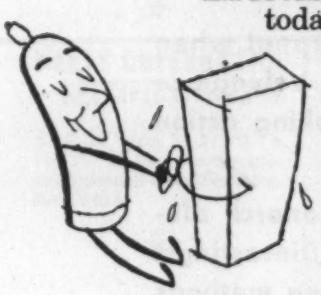


If ammonia, the versatile chemical, applied for a job, the interview would probably go like this:

EMPLOYER: How old are you?

AMMONIA: Many centuries. I helped the ancient Egyptians bleach cloth 3,000 years ago.

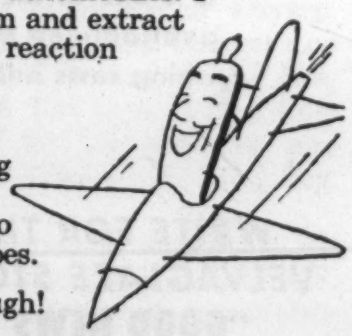
EMPLOYER: Amazing! But what do you do today?



AMMONIA: I grow farm crops, make ice, purify water, produce explosives.

EMPLOYER: I know you are a fertilizer, a refrigerant, and . . .

AMMONIA: Yes, and I serve as a protective atmosphere to surface-harden and anneal vital parts of planes and automobiles. I neutralize acid in petroleum and extract metals from ores. I'm a solvent and reaction medium in organic synthesis, a nutrient for yeast and a processing agent in the manufacture of alkalis, rayon, dyes, butadiene, and catalysts for cracking petroleum. I'm used in making vitamins, sulfa-drugs and radio and television parts and tubes.



EMPLOYER: Whoa—that's enough! What can you do for us?

AMMONIA: Just let one of our technical men talk it over with your chemists. He can usually find an answer that will speed up some process and save you dollars.

Barrett* Brand Anhydrous Ammonia in Cylinders

FORMERLY SOLD BY THE BARRETT DIVISION
NOW SOLD BY

Nitrogen Division

ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

*Reg. U. S. Pat. Off.

News Digest

Washington 25, D. C. Microfilm, $9.00. Enlargement Print, $70.00. Treats: Light metals—casting—Germany. English abstract included. No. PB 106835.

"Titanium-Columbium, Titanium-Molybdenum and Titanium-Silicon Phase Diagrams, Armour Research Foundation, Chicago, Ill. Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm, $5.00. Photostat, $16.50. The titanium-columbium, titanium-molybdenum and titanium-silicon systems were determined using alloys cast in consumable and nonconsumable electrode inert atmosphere arc melting furnaces. Working and annealing treatments were carried out under conditions that minimized contamination of the high purity alloys. Micrographic analysis after isothermal annealing, followed by quenching, was the chief method used for phase identification. No. PB 106954.

"Magnesium Coating and Corrosion (Including Cathodic Protection). A Literature Survey: U. S. Office of the Quartermaster General." Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Mimeograph, $1.00. This literature survey has been prepared to furnish Quartermaster technicians with existing methods for evaluating the performance of magnesium coatings on base metals and to present information dealing with corrosive influences on these coatings in order that new products may be developed to meet new, more stringent acceptance tests. The scope of the present survey is limited to the years 1946-1951. No. PB 106654.

"Oxidation of Metals and Alloys." Available from National Advisory Committee for Aeronautics, 1724 F St., N. W., Washington 25, D. C. This paper reviews the various types of oxidation processes occurring with pure metals and gives explanations for the varying time-temperature-oxidation rate relations that exist for copper, tungsten, zinc, cadmium and tantalum. The effect of shape and crystal structure on oxidation is discussed. Translated from *Zeitschrift fur Metallkunde*. No. PB 106976.

(More News on page 250)

ANOTHER CHAPTER IN
THE HISTORY OF LEPEL

LepeL's NEW HOME

JUST ACROSS THE EAST RIVER IN WOODSIDE, NEW YORK CITY

The new building containing our new factory and offices, designed on the most modern architectural lines, reflects the steady gains made by Lepel for a quarter of a century.

The reputation enjoyed by Lepel in the field of Induction Heating equipment has been made possible by the high quality of the Lepel products and the integrity of the Lepel organization with its pleasant customer relationship.

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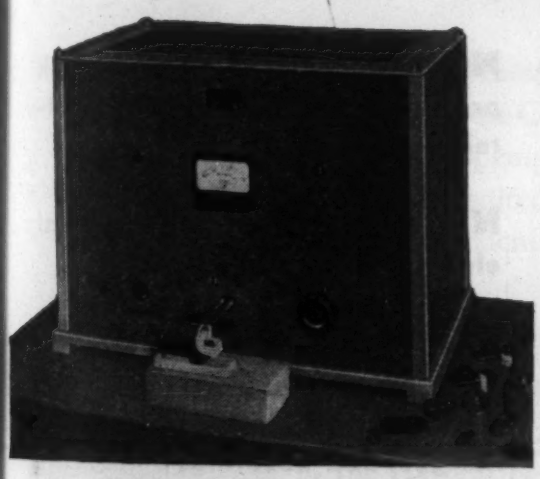
HIGH FREQUENCY
Induction
HEATING UNITS

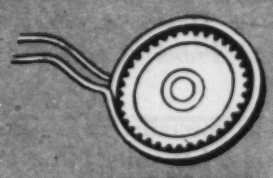
SPARK GAP CONVERTERS
from 4 kw to 30 kw

ELECTRONIC TUBE GENERATORS
from 5 kw to 50 kw

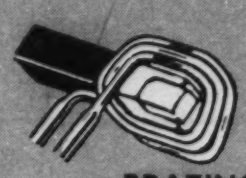


LOW COST 2 KW PORTABLE UNITS
Spark Gap operated on 110 volts

ANY LEPEL UNIT DOES THESE JOBS— *faster better cheaper*



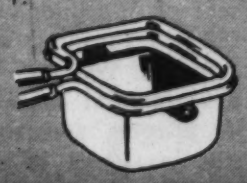
HARDENING
Heat localized exactly where wanted, to any desired temperature up to 5000° F.

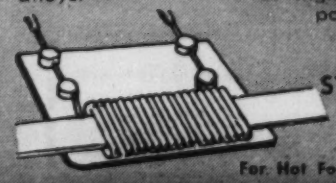


BRAZING
Permits widest choice of copper or silver brazing alloys.

MELTING
Readily melts metals and alloys of high melting point.

SOLDERING
Neater, faster, without waste or discoloration.





ANNEALING
STRESS RELIEVING
NORMALIZING
PRE-HEATING
For Hot Forging, Hot Drawing, etc.

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HIGH FREQUENCY LABORATORIES INC.

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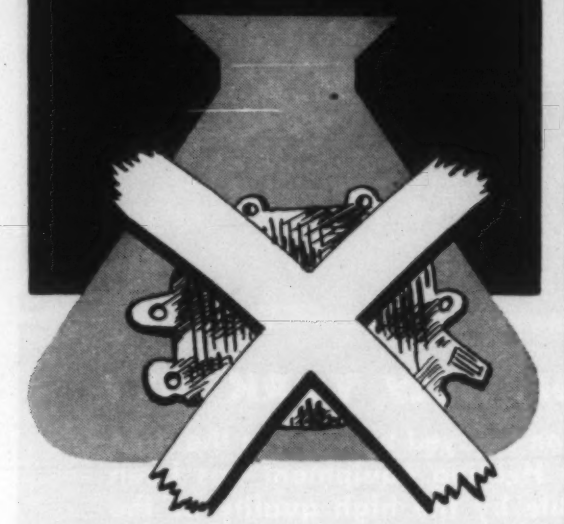
All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission

Remove Occluded Salts with DU-LITE "SD"



"Creeping salts", the residual reaction often following the black oxidizing of metals, can now be removed without special equipment with Du-Lite "SD". This new compound eliminates special rinses and extra handling which have previously been required. "SD" was developed specifically to remove trapped salts from the surface of porous, laminated, sintered, spot-welded, and similar parts.

Du-Lite "SD" can be used in an ordinary iron tank. It completely removes all salts with a visible "boiling" action, even in blind holes and the most irregular surfaces. "SD" requires no strength tests and only the normal dragout need be replaced.

In addition, "SD" liquid compound leaves a light protective coating which in many cases provides a satisfactory final finish.

Production proven "SD" liquid compound is available immediately. Descriptive bulletin is being mailed to all Du-Lite users; if you haven't received yours, write today to "The Finishing Specialists".

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Send more information on Du-Lite "SD"..... ☐
Send information on metal finishing products.. ☐
Have your representative call..... ☐

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Company.....
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City..... Zone..... State.....
5

Du-Lite
METAL FINISHING SPECIALISTS

News Digest

News of Engineers

Dow Chemical Co. has announced three high level changes in its research staff, with *L. C. Chamberlain,* manager of research for its plastics department being named assistant to the director of research. *Raymond F. Boyer* will replace Mr. Chamberlain, and Dr. *William C. Bauman* will succeed Mr. Boyer as director of the company's physical research laboratory.

Dr. *C. J. Breitwieser* has been named director of engineering by P. R. Mallory & Co., Inc. He previously served the company as executive assistant to the vice president in charge of engineering.

Fairbanks, Morse & Co. have announced that *R. H. Morse, III* has been appointed general manager of the company's Beloit, Wis. Works.

The following appointments have been announced by Boonton Molding Co. *Frederick K. Davidson* has been elected senior vice president to head research and development. Mr. Davidson has been a vice president for the past ten years. The appointment of *Roger M. Daugherty* as general manager of operations has also been announced. Previously, Mr. Daugherty served as vice president of J. H. Bunnell and Co.

Arthur E. Stevenson, assistant to the general manager of the Research Div., Continental Can Co., has retired after 26 years with the company.

Appointment of *Helmut Thielsch,* formerly of the Welding Research Council, to the position of director of applied welding engineering at Eutectic Welding Alloys Corp. has been announced.

W. S. Shamban & Co. has announced the appointment of *Henry A. Traub* as chief engineer and *Frank R. Chaffin* as research director.

John Fletcher, as specialist in varnishes and synthetic resins, has joined the staff of National Research Corp.

After 43 years of service, *Paul Diserens,* director of research and development of Worthington Corp. and its subsidiary companies, is retiring. Mr. Diserens will continue with the corporation in a technical consulting capacity. *Ralph M. Watson,* assistant to the vice president in charge of engineering, succeeds Mr. Diserens. The company has also announced four promotions in the Buffalo plant. *Harold W. Whiting* has been named assistant to the executive engineer; *W. A. Scheerer* has been appointed chief engineer, Compressor Div.; *W. J. Blessing* has been named consulting engineer;

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NO BURN OUTS in thin sheets. Engineered projections prevent.

NO RETAPPING. Shank protects threads from weld spatter.

NO PILOTS or costly special electrodes.

NO INDEXING. Round, compact shape eliminates orientation. Permits use on narrower flanges. Self Locating.

YES. PEM WELD FASTENERS will do a better fastening job at lower cost, wherever load carrying threads are required in thin metals that may be welded. Write for literature and samples for trial. Penn Engineering & Manufacturing Corp., Doylestown, Pa.

PEM

CHASE® PHOSPHOR BRONZES

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VISIT *the Chase booth no. 1200 at the National Metal Congress and Convention*

high strength

high fatigue resistance

excellent corrosion resistance

good ductility

great resilience

WHAT metal is best for bearings? For diaphragms? For *any* tough production job that requires a metal of superior qualities? Chase Phosphor Bronzes may be the answer.

These tin bronzes are superior to many other metals for a wide variety of functions. Some Chase Phosphor Bronzes are ideal for fuse clips, spring contacts, bellows, lock washers. Others are suited for bearings, bushings, gears, pinions, screw machine parts. They are made in Rod, Strip or Wire.

Chase Phosphor Bronzes... like all Chase metals... are carefully controlled as to quality to provide a high standard of surface finish and excellent internal characteristics. Fill in the coupon below and we'll send you the free Chase folder.

FREE Folder gives tables of Chase Phosphor Bronze properties (hardness, tensile, fabrication, physical) as well as uses and forms.

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Please send me the free folder on Chase Phosphor Bronzes.

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Position_____

Company_____

Street_____

City_____ State_____

One man and a C-F Lifter...

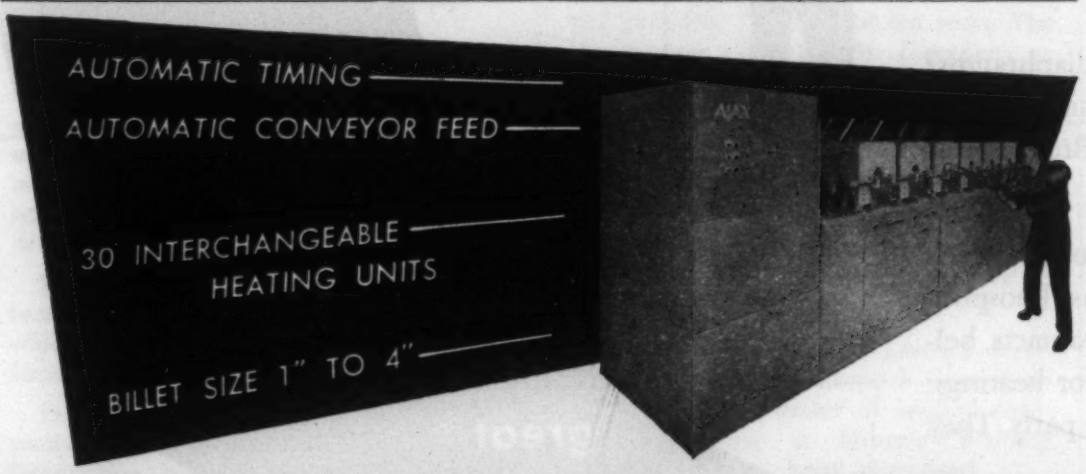
One man and a C-F Lifter handle the sheet steel stock in and out of storage in this plant with ease, speed and economy. C-F Lifters can pick up, carry and unload more loads per hour using less man and crane time than any other method. Note how closely a C-F Lifter piles sheets—this results in great savings in storage space. Jaw adjustments for carrying different widths of sheets are made in a few seconds by the operator—an important feature when varying sizes of stock are used.

C-F Lifters are made in sizes to handle from 2 to 60 tons in standard and semi-special designs.

Write for the bulletin "C-F Lifters." It illustrates the many cost saving advantages of these lifters.

CULLEN-FRIESTEDT CO.
1314 S. Kilbourn Ave., Chicago 23, Ill.

HANDLE SHEETS with C-F LIFTERS



8500 pounds of scale-free uniformly heated billets per hour

This super-flexible Ajax-Northrup induction heater was designed for a leading manufacturer of automotive forgings. It can be adapted to heat billets for almost any forging job in the plant in a matter of minutes—automatically!

Other Ajax-Northrup units for forging, heating, brazing, melting and other hot jobs can be engineered to fit any of your production lines. Write us today for more details.

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145-S

News Digest

and *William M. Kauffmann* has been made chief engineer, Engine Div.

The following appointments and changes have been announced by General Electric Co. A decentralization of the company's Fractional Horsepower Motor Dept. into four separate sub-departments, each with a general manager, has been announced. The new departments and their managers are: General AC Motor Sub-Dept., *Lisle D. Hodell;* Hermetic Motor Sub-Dept., *A. Martin;* Specialty Motor Sub-Dept., *Jack J. Clarkson;* and Electric Sink and Laundry Motor Sub-Dept., *Carl W. Moeller.* Headquarters for all four groups will be at Fort Wayne. Appointment of *W. O. Meckley* as manager of engineering for the company's newly formed Accessory Turbine Organization at the Lynn River Works has also been announced. Other appointments at the Lynn River Works are: *T. N. Ferrea* as superintendent of manufacturing; *F. W. Dahlberg* as facilities engineer; *J. W. Shirley* as production manager; and *A. C. Eastman* as supervisor of inspection. The company's Chemical Div. has announced the appointments of Dr. *Robert H. Krieble* as manager of engineering for the Chemical Materials Dept. of the division and of *George M. Yesse* as manager of facilities engineering. According to another recent announcement from the company, *Donald A. Hilliard* has been named supervisor of quality control for the company's Chemical Div. alkyd resin plant at Schenectady.

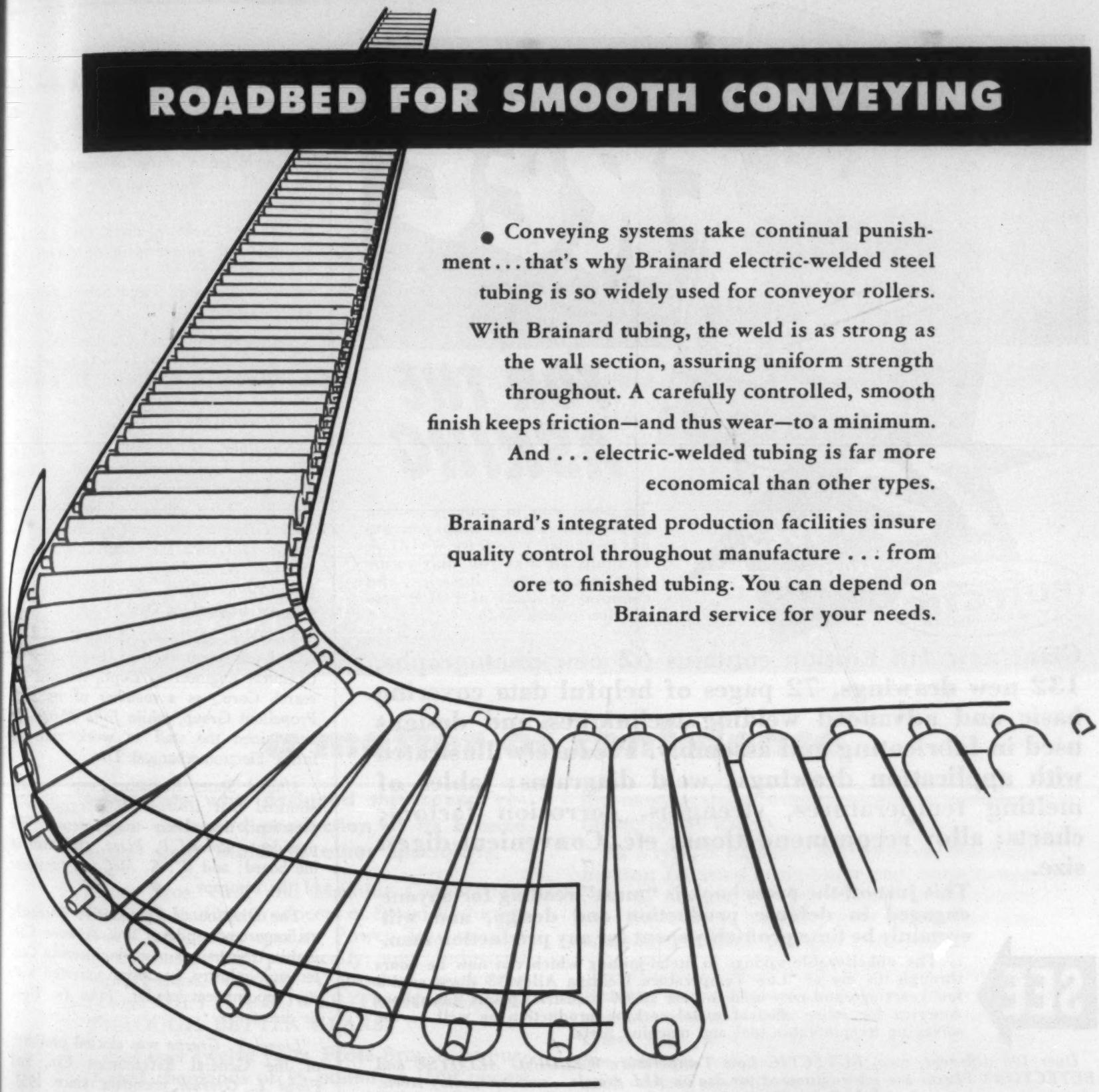
Establishment of a Films, Foam and Flooring Div., coordinating development, production and sales of these products, with *Joseph E. Mayl* as general manager, has been announced by Goodyear Tire & Rubber Co. Mr. Mayl will continue as vice president of the company.

Promotions among top executives of

(Continued on page 254)

another job for **Brainard** TUBING

ROADBED FOR SMOOTH CONVEYING



● Conveying systems take continual punishment . . . that's why Brainard electric-welded steel tubing is so widely used for conveyor rollers.

With Brainard tubing, the weld is as strong as the wall section, assuring uniform strength throughout. A carefully controlled, smooth finish keeps friction—and thus wear—to a minimum. And . . . electric-welded tubing is far more economical than other types.

Brainard's integrated production facilities insure quality control throughout manufacture . . . from ore to finished tubing. You can depend on Brainard service for your needs.

EASILY FABRICATED

Brainard tubing is a uniform product made to close tolerances. Has good machining qualities and finish can be supplied as specified. Easily fabricated—can be beaded, expanded, swaged, spun, flanged, upset, grooved, fluted, flattened, tapered, and otherwise formed. Supplied straight or fabricated, sizes ½″ to 4″ O.D.; .025 to .180 gage.

Fast delivery on certain sizes. For further information or catalog, write Brainard Steel Division, Sharon Steel Corporation, Dept. X-10, Griswold Street, Warren, Ohio.

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72 PAGES
PROFUSELY ILLUSTRATED

Low Temperature EUTECTIC WELDING ALLOYS

To assist you in your re-tooling problems . . . or to help you analyze your present welding methods so that you may enjoy maximum speed, efficiency, and economy in many of YOUR production problems . . .

Giant new 4th Edition contains 62 new photographs, 132 new drawings, 72 pages of helpful data covering basic and advanced welding techniques and designs used in fabricating and assembly. Profusely illustrated with application drawings; weld diagrams; tables of melting temperatures, strengths, corrosion factors; charts; alloy recommendations; etc. Convenient digest size.

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News Digest

Aluminum Industries, Inc. have been announced: *Eugene F. Eckerle* has been named general manager, *Richard G. Tessendorf* was promoted to assistant general manager in charge of manufacturing, and *John H. Hater* succeeds Mr. Eckerle as secretary.

Hooker Electrochemical Co. has announced the appointment of *Charles A. Strack* to head up research and testing work in its new Virgo Salt Laboratory at Niagara Falls.

American Cyanamid Co. has announced that *L. R. Forrest* has been transferred to the Warners Plant, Linden, N. J. where he will serve as staff assistant to the works manager.

Appointments of *M. J. Merlin* as Cleveland factory manager and of *Hugh S. Highet* as chief manufacturing consultant have been announced by the Cleveland Graphite Bronze Co. Another announcement from the company states that *William G. Laffer* has been made vice president-operations of the company's original Equipment Div.

Erling F. Rosholdt, chemical engineer and development chemist, has joined the Chemical Engineering Dept., Atlantic Research Corp., as a member of its Solid Propellent Group, while *John Mason, Jr.* has joined the staff to work with the firm's Electromechanical Div.

United States Radiator Corp. has announced that *Howard B. Steggall,* vice president, has been made senior vice president; *Roland P. Place,* chairman of the board; and *W. C. McCord,* president of the company.

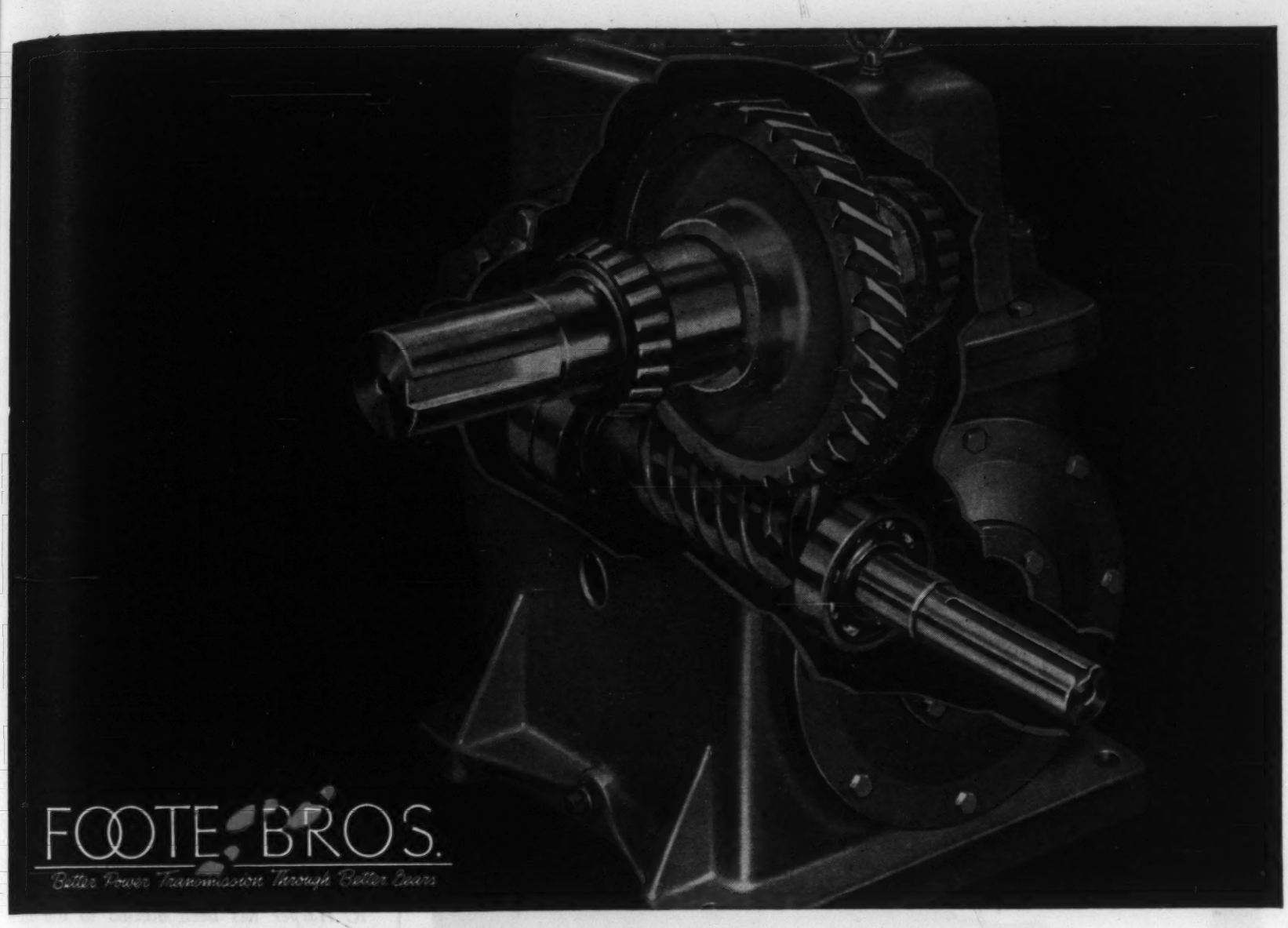
The Division of Cooperative Research, an important top-level link between Columbia University's new Engineering Center and industry, has been activated with the appointment of Dr. *John G. Dean* as director.

Lionel Y. Greene was elected president of the General Refractories Co., and *Floyd L. Greene,* president since 1937, was elected to the post of chairman of the board.

Robert Johnson, a member of the general factory engineering staff at National Electric Products Corp.'s Ambridge, Pa. plant, has been appointed product engineer in charge of engineering development of Underfloor Raceway, Surface Raceway, Plug-In Strip and Mechanical Connectors.

John E. Hawley has joined the Pennsylvania Salt Manufacturing Co.'s Research and Development Div. at the Whitemarsh Research Laboratories.

Two staff promotions in General Motors Research Laboratories have been announced. Named assistant technical director on the general manager's staff is *John M. Campbell.* Succeeding Mr. Camp-



a matter of confidence

Specialists who designed this speed reducer entrusted production of its bronze worm gear blank to other specialists.

Foote Bros. Gear and Machine Corporation, Chicago, leading producers of Speed Reducers, Gears, and other quality Power Transmission Components for practically any industrial requirement, identify themselves with the phrase "BETTER POWER TRANSMISSION THROUGH BETTER GEARS."

For over twelve years, Foote Bros. have purchased thousands of ½ pound to 1500 pound non-ferrous gear blanks from National Bearing Division—confidently entrusting their reputation and industry leadership to special foundry skills for which National Bearing is famous.

And Foote Bros. confidence is well placed.

National Bearing's proven ability to mass produce exceptionally fine-grained, non-ferrous castings, free from blow holes and sand inclusions, can be depended upon under even the most exacting engineering and manufacturing specifications.

As a typical customer service-plus, National Bearing Division's engineers and foundrymen recently designed, and produced for customers like Foote Bros., a bronze gear blank that contains even higher physical properties.

Through a new foundry technique, National Bearing imparts greater hardness, finer grain, and more tensile strength to the bronze gear blank ring, to a depth below where the teeth are cut. In addition, this new process gives such extra advantages as higher uniformity, closer tolerances, and economy of stock.

If your product requires special mass-produced non-ferrous castings or bearings, National Bearing Division has the foundry facilities, experience, and skill that will insure better product performance, and may possibly lower product costs through production-run economies. You are invited to write to National Bearing Division for complete information.

AMERICAN Brake Shoe COMPANY

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PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

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the HEVI-DUTY *Multi Purpose* FURNACE

for

TOOL ROOM AND
EXPERIMENTAL HEAT TREATING

WITH a maximum temperature of 1850° F., the TREET-ALL can easily handle your scale free hardening, carburizing, dry cyaniding and silver brazing. The alloy muffle and gasketed door form a tight seal which simplifies atmosphere control. For hardening, an atmosphere generator is not necessary; raw gases, such as bottled or natural gas, can be used to provide the atmosphere. The furnace, quench tank, cabinet and controls form a compact, completely wired unit.

TREET-ALL furnaces are built in 3.6 KW and 8 KW sizes with inside muffle dimensions of 7" W x 15" L x 4-7/8" H and 10" W x 18" L x 7½" H respectively.

Write for Bulletin HD-1147-BB

HEVI DUTY ELECTRIC COMPANY

HEAT TREATING FURNACES HEVI-DUTY ELECTRIC EXCLUSIVELY

DRY TYPE TRANSFORMERS — CONSTANT CURRENT REGULATORS

MILWAUKEE 1, WISCONSIN

News Digest

bell as head of organic chemistry is Dr. *Lloyd L. Withrow*. Appointment of *Maurice A. Thorne* as engineer in charge of GM's engineering staff vehicle development group has also been announced by the company.

H. P. Smith Paper Co. has announced the appointment of *Charles A. Southwick Jr.* as technical director in charge of research and development.

Walter Sokolofsky has been named foundry service engineer for Monsanto Chemical Co.'s Plastics Div.

Charles D. Townsend has been appointed director of manufacturing at La Pointe-Plascomold Corp., according to a recent company announcement.

Lester A. Shea, on leave of absence as general sales manager of Lindberg Engineering Co., has been selected chief, Industrial Heating Equipment Section, Metalworking Equipment Div. of the National Production Authority.

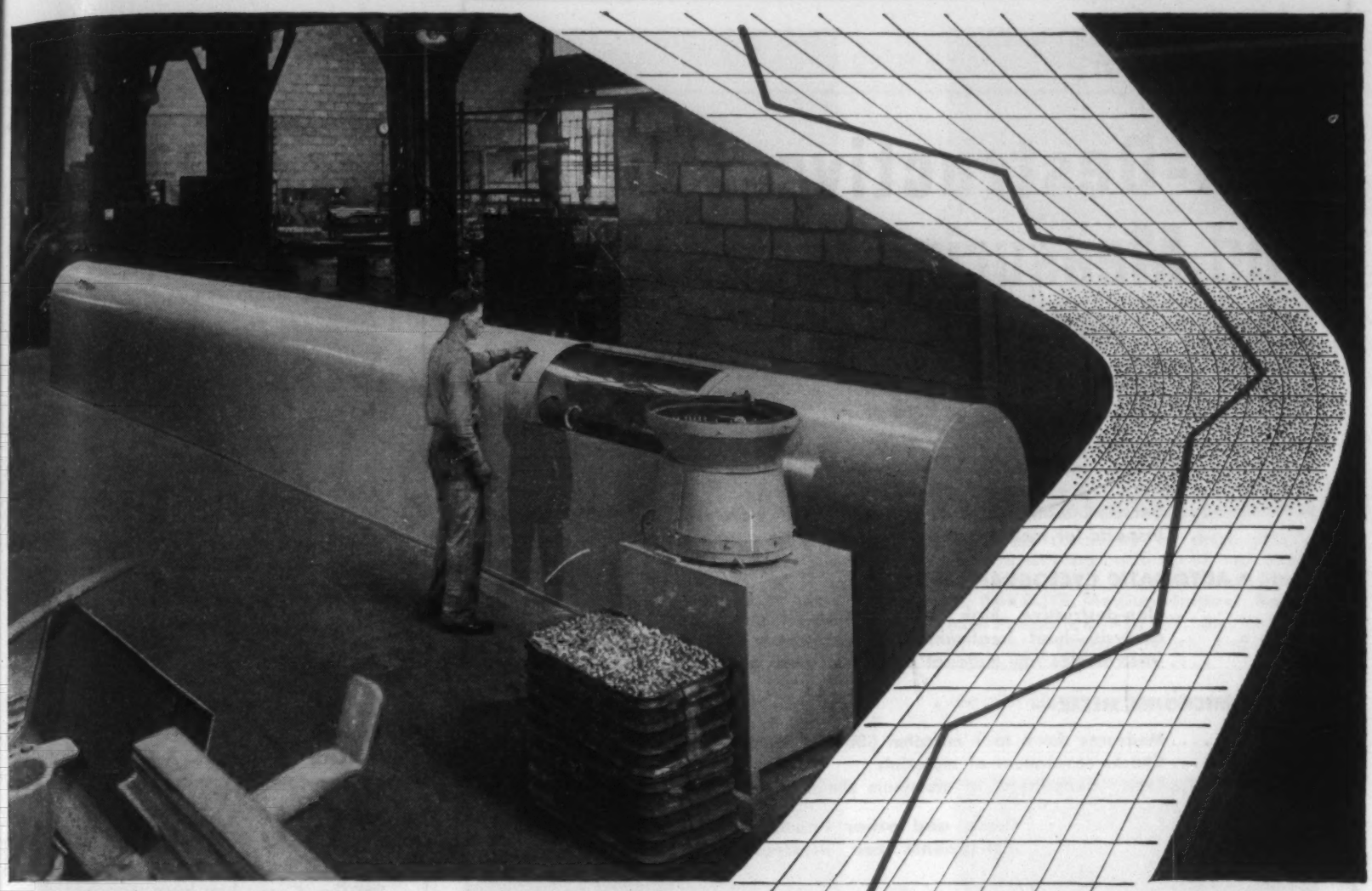
Election of two new vice presidents and the reorganization of executive personnel in Pittsburgh Plate Glass Co.'s Manufacturing, Merchandising and Glass Sales Divs. has been announced. *Wallace R. Harper* has been elected to the new position of vice president in charge of Plate Glass Sales; *David G. Hill,* general superintendent of Plate Glass factories, has been named vice president in charge of Glass Manufacturing; *Donald C. Burnham,* who has been vice president in charge of Glass Sales and the Merchandising Div., will devote full time to the company's rapidly expanding Merchandising Div.; *Ralph V. Reisgen* has been appointed general superintendent of Plate Glass factories, succeeding Mr. Hill; *Robinson F. Barker* has been named assistant to the president; and *Thomas G. Wright* has been promoted to the newly created position of superintendent, fabricating. Appointment of Dr. *George S. Bachman* as director of research of the company's new Fiber Glass Div. has also been announced.

John A. Goodwin has been appointed general manager of Morrison Engineering Corp.

Ray A. Mentel, recently associated with Perfection Stove Co., has been appointed vice president and general manager of Republic Hardfacing Corp. *Gorham W. Woods* has joined the company as engineer and will be in charge of the Industrial Hardfacing Div.

Stanley C. Johnson has been named chief abrasive inspector for Norton Co., replacing *Harry O. Anderson,* who recently retired after 51 years with the company.

Galvanic Products Corp. has announced the appointment of *Earl Steiker* as general manager of the company's Rectifier Div.



An automatic heat treat machine. Production is about 3 times that possible with manual methods while quality is held within very close limits.

CRUCIBLE ALNICO MAGNETS

KEEP COSTS DOWN . . . *through automatic production that gives quality control*

Alnico magnets have been getting smaller and lighter, thanks to production techniques in use at Crucible. Automatic machinery cuts the possibility of human error to a minimum, so rejections are low. This helps to maintain stable price levels in the face of rising material and labor costs. At the same time, Crucible's rigid inspection standards and attention to quality have developed a magnet with the *highest gap flux per unit weight of any on the market.*

Today, Crucible can offer lighter, magnetically stronger Alnico magnets because of these automatic production techniques developed over the sixteen years that we have been producing the Alnico alloys. And behind our familiarity with permanent magnets lies more than 52 years' experience with specialty steelmaking. Let us advise you on your magnet problem.

CRUCIBLE first name in special purpose steels

52 years of Fine steelmaking

PERMANENT ALNICO MAGNETS

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STAINLESS • REX HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

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Bulletin No. 21

UNUSUAL

Non-Destructive Testing and Measuring Instruments

- **ELECTRONIC MICROMETER—**
  - .... *Direct* measurements to .000020"—*not* a comparator
  - .... Measures without pressure on work—eliminates "feel"
  - .... Measures *any* material, hard or soft
- **ULTRASONIC METROSCOPE—**
  - .... Measures wall thicknesses *from one side only*
  - .... Detects internal defects *non-destructively* in metals and other materials
  - .... Inspects for lack of bond
- **AUTOMATIC CYCLOGRAPH—**
  - .... Non-destructive, high speed sorting of metals and metal parts by analysis—heat treatment—hardness—depth of case or decarb, etc.
  - .... Unscrambles raw material or finished parts mixups, but quick!
- **MICROHM METER—**
  - .... Measures down to 1 microhm (.000001 ohm)
  - .... Checks resistances of materials
  - .... Tests "cleanliness" of aluminum sheet prior to welding

These and other unusual non-destructive testing instruments are illustrated in Bulletin No. 21

J. W. DICE COMPANY **ENGLEWOOD, N. J.**

A·S·R asked

Where to get a small handle button, wear-and-water-resistant . . . light enough to be set in plastic . . . produced in large quantities, quickly and inexpensively?

GRC* answered

Tiny GRC precision zinc die castings will make ideal handle buttons for the new Gem razor . . . meet to a T every ASR specification!

ASR's GEM

American Safety Razor's new Feather Weight Gem Razor weighing only 1 1/10 oz.

*WITH GRC TINY PRECISION ZINC DIE CASTINGS

If obtaining really small parts speedily and economically is your problem, too, why not let GRC tackle it? Gries' revolutionary, high speed, mass production methods are geared to turn out simple or intricate parts in one operation. Trimmed, ready for use . . . GRC zinc die castings as small as .000004 of a lb. in lots from 100,000 to millions . . . at a price to help you produce at a profit! Remember . . . it's GRC for *smallness unlimited.*

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MAX. WT. - 1/2 OZ.
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News Digest

The election of *Henry S. Freynik* as vice president of The Riverside Metal Co. has been announced.

George McCuskey has joined the Youngstown Sheet and Tube Co. as assistant to the president.

R. S. Stevenson has been elected executive vice president of the Allis-Chalmers Manufacturing Co. at a recent board meeting. *Willis G. Scholl,* formerly vice president and general sales manager of the Tractor Div., replaces Mr. Stevenson as vice president in charge of the Tractor Div. *Frank Mussell* will succeed Mr. Scholl.

J. Gordon King, vice president, Owens-Illinois Glass Co. and manager of glass container production, has been named general manager of the Kaylo Div. He succeeds *Thomas A. Collins,* who is resigning to accept a position with another company.

Appointment of *Billy B. Curl* to the technical staff of Russell Reinforced Plastics Corp. has been announced.

Arthur M. Simpson has been named vice president of research and development, The Kawneer Co. Mr. Simpson formerly held the position of vice president and general manager of the Kentucky Div. of the company. His successor in that position is *George H. Shevlin, Jr.,* formerly assistant to the president.

Vulcan Rubber Products, Inc. has announced the appointment of *W. P. Frisco* as factory manager. Mr. Frisco was technical director of the St. Clair Rubber Co. until he assumed his new position with Vulcan.

Dr. *Charles A. Culver,* senior physicist for Southwest Research Institute and Dean of Professional Development at the Essar Research Center, has been appointed chairman of the Trinity University Dept. of Physics.

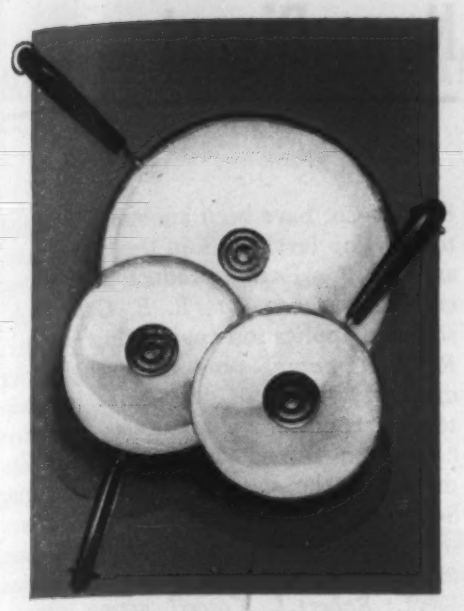
Byron G. MacNabb has joined the Research & Development staff of Alloy Engineering and Casting Co. as associate director. He will be primarily concerned with coordination of all armed services research and development projects.

Appointment of *Robert W. Ayling* as an additional development engineer on the staff of the Brunner Manufacturing Co. has been announced.

Otto J. Blank, formerly plant manager of the R. M. Hollingshead Corp., has been appointed vice president in charge of production.

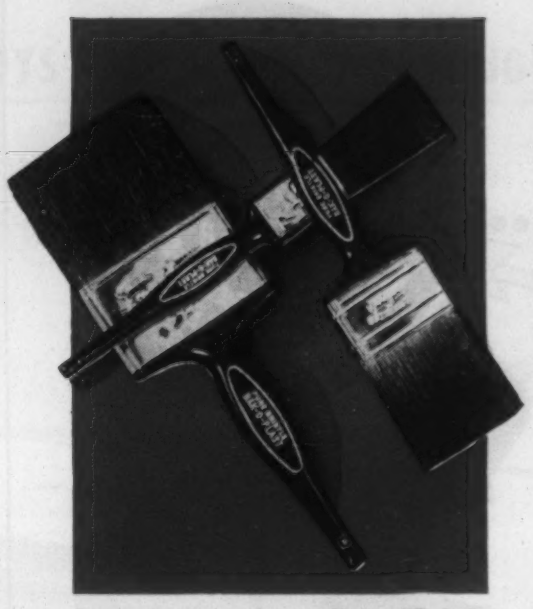
Erwin F. Bender, for many years manager of the New York office of Kinney Manufacturing Co., has retired after 41 years with the company.

Four new appointments to newly created executive positions on the engineering staff of Carboloy Dept., General



Smart design, fine finish, heat resistance, and low heat conductivity are all found in handles and knobs for famous Revere Ware. They're Black **BAKELITE Heat-Resistant Phenolic BM-13335.**

Molded for Revere Copper and Brass, Inc., Rome, N. Y., by Diemolding Corp., Canastota, N. Y., Auburn Button Works, Auburn, N. Y., and Norton Laboratories, Lockport, N. Y.

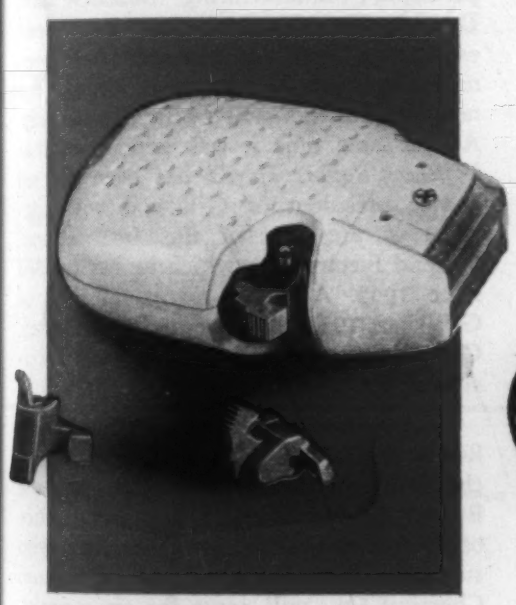


Impervious to solvents, Baker "Bak-O-Plast" paint brush handles stay smooth and comfortable to the touch. Well balanced, strong, easily produced, they're made of **BAKELITE General-Purpose Phenolic Plastic BM-18450.**

Molded by Shaw Insulator Co., Irvington, N. J., for Baker Brush Co., New York, New York.

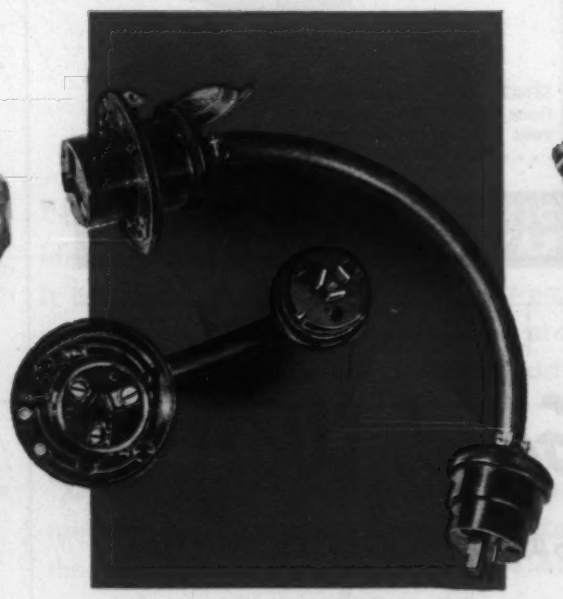
Electrical resistivity of these textile pulleys prevents build-up of high static charges as fibers pass over them. Made of **BAKELITE Medium-Impact Resistant Phenolic BM-14111,** they're light in weight, strong, smooth, and wear-resistant.

Made by Meadows Mfg. Co., Atlanta, Ga.



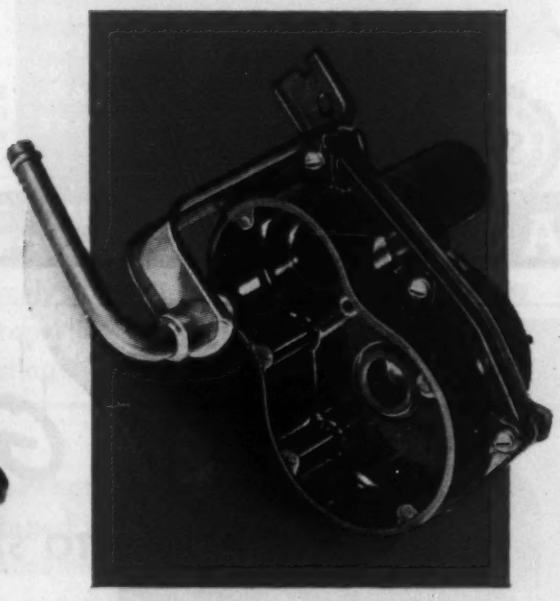
Complex shape, close tolerances, good color, and durability characterize starter buttons for Schick "20" electric shavers. Made of Tan **BAKELITE General-Purpose Phenolic BM-17020,** they have excellent insulating properties and are rapidly mass produced by transfer molding.

Molded by Shaw Insulator Co., Irvington, New Jersey.



This heavy-duty three-terminal electrical connector for trailer coaches has plug and receptacle of Black **BAKELITE Improved-Impact Phenolic BM-6260.** They stand up under a 30 amp., 110 volt current, are resistant to mechanical shock and to moisture.

Molded for Theodore Bargman, Detroit, Mich., by Molded Products Company, Detroit, Mich.



Impact strength, smooth durable finish, and resistance to heat and moisture qualify phenolic plastics for this job! It's an aspirator in the Bendix Economat clothes washer, molded of Black **BAKELITE Impact and Alkali-Resistant Phenolic BM-13080.**

Molded by Plastic Research Products, Urbana, Ohio.

Why they picked Phenolic Plastics!

What do *you* want for *your* product? Good finish? Impact strength? Dielectric strength? Resistance to wear, moisture, or chemicals? Simplified production?

Like the manufacturers of these products, you may find the right combination of properties among BAKELITE Phenolic Plastics. Their wide variety means that you can pick the plastic fitted to your particular needs. Their broad range of properties makes them useful for thousands of applications.

Why not look into BAKELITE Phenolic Plastics as a means of improving design, production, performance and sales? Our engineers will help you. Just write Dept. DY-17.

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PHENOLIC PLASTICS

TRADE MARK

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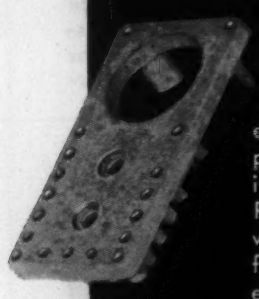
PRIME CONTRACTORS SEE "ACCURATE" FOR MILITARY COMPONENTS

The manufacture of molded plastics for devices for military requirements is one of our specialties . . . thousands of military parts are in present production.



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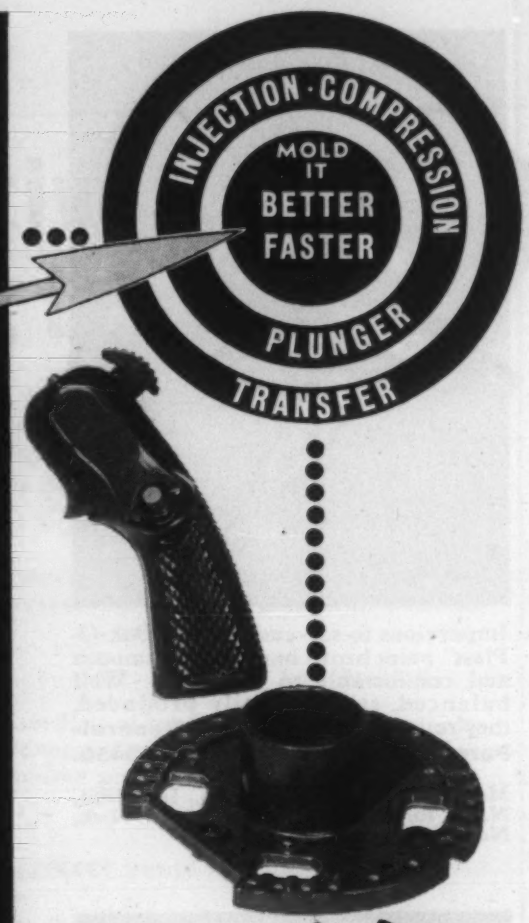

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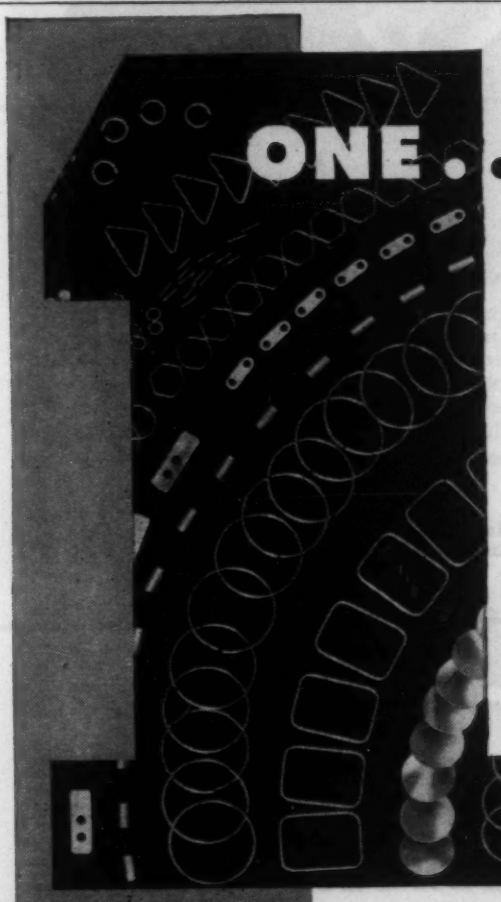

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News Digest

Electric Co. have been announced. Named to new top level posts in the organization are: *E. W. Engle,* product and process engineering manager; *E. E. George,* design and application engineering manager; *R. A. Canning,* production engineering manager; and *R. L. Brownlee,* administrative engineer. Four G-E executives have been named to head new departments in the company's Manufacturing Services Div. Appointees and their new departments are: *C. Willard Bryant,* manager of materials, Materials Services Dept.; *Robert L. Yowell,* acting manager of manufacturing facilities, Manufacturing Facilities Services Dept.; *William W. Beardslee,* manager of manufacturing engineering, Manufacturing Engineering Services Dept.; and *John S. MacDonald,* manager of manufacturing administrative practices, Manufacturing Administrative Practices Services Dept. A fifth new department, Manufacturing Research and Development Services, has also been established, but no manager has been named as yet. Headquarters of all the new departments will be in Schenectady. At the same time it was announced that *William Rogers Herod* has been elected a vice president of G-E and will continue as president of the International General Electric Co., which he has headed since 1945. A wholly-owned affiliate of G-E since 1919, the International Electric Co. has merged with and become a division of the parent company.

T. V. Monahan, assistant treasurer of Rohm & Haas Co., has been appointed chief of the chemical branch of the Rubber, Chemicals and Drugs Div., Office of Price Stabilization. Mr. Monahan, who succeeds *Patrick Dowd* of Monsanto Chemical Co., will serve for six months.

Appointment of *Donald R. Guthrie* as executive engineer in charge of engineering research has been announced by Minnesota Mining & Manufacturing Co.

Appointment of *Charles Harmon* as general plant superintendent of the Chrysler Detroit Tank Plant has been announced.

Raymond T. Whitzel has been made general manager of the Smelting Div., Aluminum Co. of America, succeeding *V. C. Doerschuk,* who has been general manager of that division since 1935. Mr. Doerschuk will become technical consultant, chiefly on aluminum smelting and related problems.

Frank R. Mahurin, a consulting ceramic engineer, has been named ceramic technologist at Armour Research Foundation of Illinois Institute of Technology. *Martin A. Elliott,* chief of the synthetic fuels research branch at the U. S. Bureau of Mines, has been appointed research professor of mechanical engineering at the Institute. A steel consulant to the nation's arms program, Dr. *Maurice J. Day,* metallurgical engineer at U. S. Steel Co., has

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New METALLURGY BOOKS

METALLURGICAL ENGINEERING

By Reinhardt Schuhmann, Jr.
Massachusetts Institute of Technology

390 pp, 155 illus, 1952, $7.50

Presents metallurgical engineering according to basic principles and unit processes rather than according to metals treated. Stresses integration of physical chemistry with metallurgical engineering and emphasizes analysis and quantitative solution of engineering problems rather than descriptive treatment of current practices.

THERMODYNAMICS OF ALLOYS

By Carl Wagner
Massachusetts Institute of Technology

161 pp, 37 illus, 1952, $6.50

Summarizes principles of thermodynamics of binary and multicomponent systems; methods of experimental determination of characteristic thermodynamic quantities such as heat of mixing formation, partial free energies of mixing, activities, etc.; methods of calculating thermodynamic quantities from other quantities which have been measured; available experimental data and indirectly obtained values; atomic and electronic interpretation of data; treatment of equilibria between alloys, salt melts, oxide melts, silicate melts, etc.

ELEMENTS OF CERAMICS

By F. H. Norton
Massachusetts Institute of Technology

246 pp, 194 illus, 1952, $6.50

Presents principles underlying the various processes used in the ceramic field with illustrative applications. Emphasis is on unit processes rather than products. A complete reference for research workers and ceramic engineers, by one of the foremost authorities of the present time.

ELEMENTS OF PHYSICAL METALLURGY

By A. G. Guy, *Purdue University*

293 pp, 218 illus, 1951, $6.50

Fundamentals of physical metallurgy with emphasis on underlying ideas of the subject rather than applications. Important applications are introduced as illustrative examples. Examples are made quantitative rather than merely qualitative. A broad, unspecialized coverage of the whole field, including an unusual appendix of the literature of metallurgy.

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News Digest

been named manager of the Materials and Processes Div. at Armour Research Foundation. Dr. Day succeeds *W. A. Casler,* who has been acting manager of the division since May 1951. Mr. Casler continues as assistant director of research and manager of program development.

Election of Vice Admiral *Carl F. Holden,* USN (Ret.) as president of Federal Telecommunication Laboratories, Inc., research unit of International Telephone and Telegraph Corp. has been announced. At the same time, it was announced that *Harold H. Buttner,* who has been president of the laboratories, will assume duties as vice president of IT&T, in New York, coordinating the research and development activities of the parent company.

Thomas B. Woersching has been named chief aerodynamicist at the Goodyear Aircraft Corp.

The appointment of *Kendall C. White* as production manager of Wico Electric Co. has been announced.

Walter H. Mickey has been named to the position of treasurer of the Barrows Porcelain Enamel Co. Mr. Mickey, who has been plant superintendent at the company for the past six years, will continue to serve in that position while serving as treasurer.

Appointment of *Charles W. Hammond* as head of the Mechanical Engineering Dept. for Walter Kidde Nuclear Laboratories has been announced.

Norman Pintchuk has joined Solar Aircraft Co.'s San Diego plant as foundry metallurgist in Solar's stainless steel foundry.

Hubert Fruehauf, manager of the Bay City Div., The Dow Chemical Co., has been appointed manufacturing manager of the Magnesium Dept.

At a recent meeting of the board of Anaconda Wire & Cable Co., *R. B. Steinmetz* was appointed vice president in charge of manufacturing operations. Mr. Steinmetz was formerly general manager of mills.

The Duraloy Co. has announced the appointment of *J. W. Zines* to the position of vice president in charge of operations.

The appointment of *Charles L. Ficker,* plant superintendent of the U. S. Steel Products Div. in Los Angeles to the position of vice president—operations of this U. S. Steel division with headquarters in New York, has been announced. *Peter C. Pianta* will fill the post vacated by Mr. Ficker. *Horace Douglass Moulton,* vice president—operations of U. S. Steel Products Div., has been appointed assistant vice president—raw materials.

Donald R. Jenkins has been appointed

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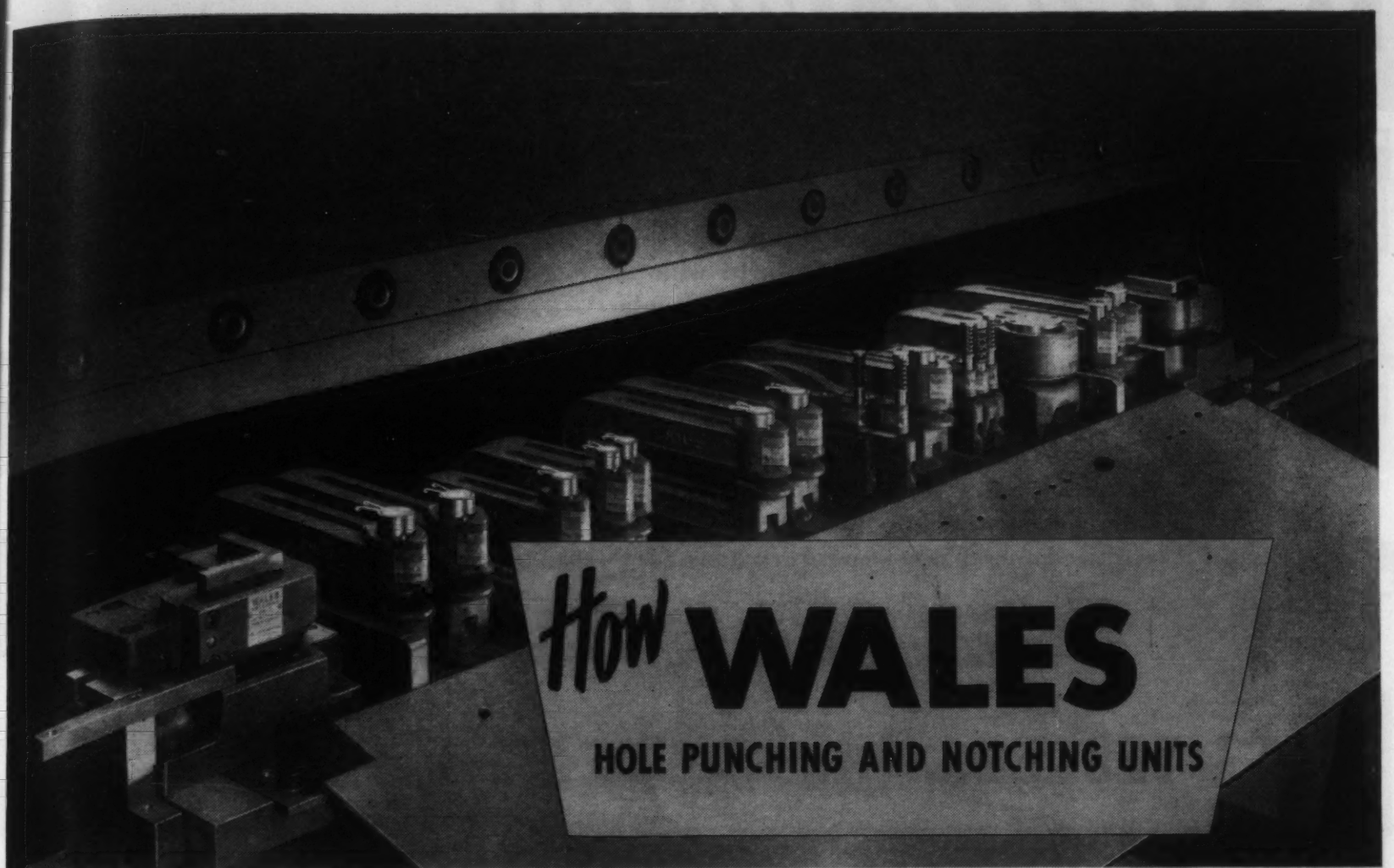
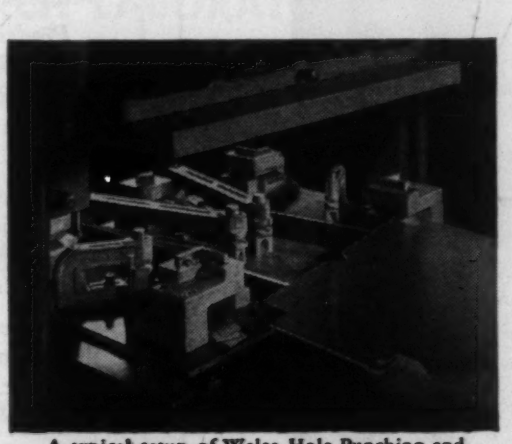
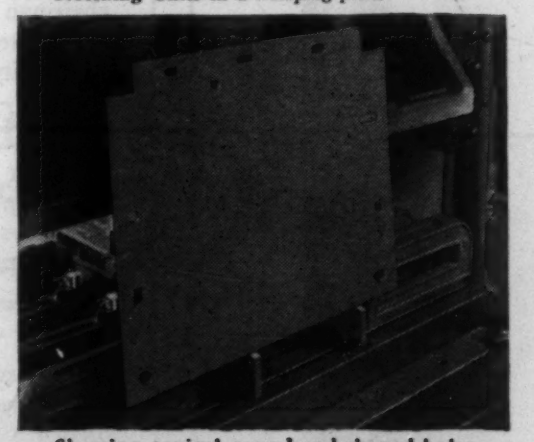


A typical *press brake* setup of Wales Hole Punching and Notching Units.



A typical setup of Wales Hole Punching and Notching Units in a *stamping press.*



Showing typical round and shaped holes punched by Wales Hole Punching Units. Note corners have been notched by Wales Notching Units.

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Scott Testers — Standard of the World

News Digest

manager of the newly formed gas turbine application engineering section of the Steam Div., Westinghouse Electric Corp.

Galvanic Products Corp. has announced the appointment of *Earl Steiker* as general manager of the Rectifier Div.

James A. Rabbitt, International Nickel Co. consulting engineer, and an authority on Japan and the Far East, will retire from active service with the company after serving for more than 22 years. Mr. Rabbitt will continue to be available to the company in an advisory capacity on Far Eastern affairs.

Henry M. Clouse has been named an assistant engineer in Allis-Chalmers' foundries and pattern shops.

The following appointments have been announced by Norton Co.: *Paul B. Foxwell* has been appointed abrasive engineer; *David Reid,* assistant superintendent of Organic Products, has been named superintendent of Grain and Bond Plants; *Roger J. Dufresne,* assistant foreman, Resinoid Dept., has been appointed assistant to the superintendent of Organic Products. The retirement of *Milton F. Beecher,* head of the company's research and development laboratories since 1941, has been announced. As chief of these facilities he will be succeeded by *Wallace L. Howe,* director of research and development.

Frederick K. Davidson has been elected senior vice president of Boonton Molding Co., according to a recent announcement. Mr. Davidson will head the company's research and development programs.

Frank N. Speller, national authority on the subject of corrosion, has become an associate member of Management Counselors. Inc.

Condenser Products Co. has announced the promotion of *Tom Murphy* to chief engineer.

E. H. MacNiece, director of quality control for Johnson & Johnson, was made chairman of the new Industry—University Committee for Quality Control at Rutgers University.

Fred D. Martin, former assistant plant manager in charge of plants 1, 2 and 4 of Speer Carbon Co., has been appointed to the plant managership of the entire St. Marys, Pa., manufacturing facilities of the company.

William C. Ayres has been named manager of materials, Hotpoint Co.

Packard Motor Car Co. has elected two vice presidents to head newly grouped management functions. They are *Albert H. Behnke* of Chicago, who has been with G-E, Hotpoint Div., for more than 20 years, and *C. Wayne Brownell,* who has been promoted from the position of manager of industrial relations at Packard.

Appointment of Dr. *Wesley S. Coe* as

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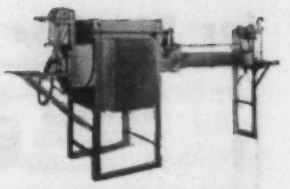

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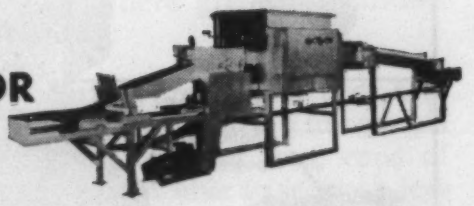

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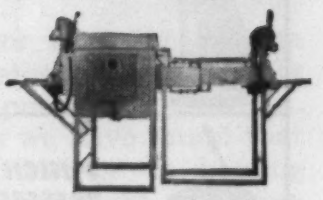

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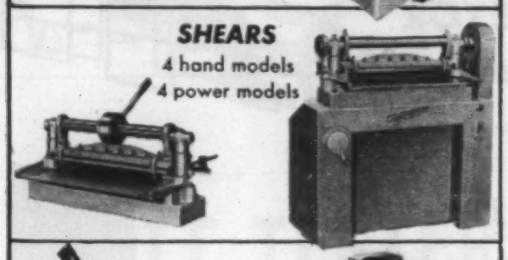
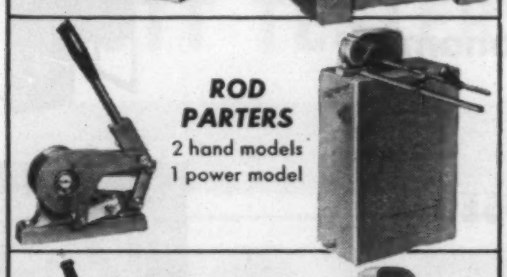


ROD PARTERS
2 hand models
1 power model



NOTCHERS
1 hand model
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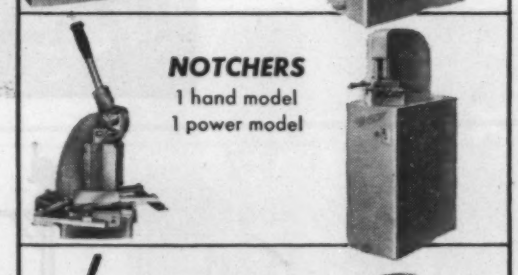

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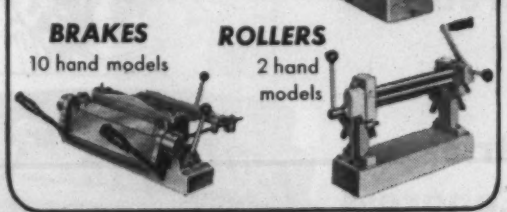
2 hand models



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News Digest

assistant factory manager of the Naugatuck plant of Naugatuck Chemical Div., U. S. Rubber Co., has been announced. *Herbert Scullin* has been named to succeed Dr. Coe as chemical production superintendent.

Horace A. Deane has been elected a vice president of Campbell, Wyant and Cannon Foundry Co., according to a recent company announcement. Mr. Deane was formerly operating vice president of the Brake Shoe and Casting Div., American Brake Shoe Co.

Thomas Cruthers, vice president of Worthington Corp. since 1936, passed on at his West Orange, N. J. home on Sunday, July 27th.

Chester H. Fisher, secretary and treasurer of Cowles Chemical Co., Cleveland, died of a sudden heart attack on July 24th.

The death of *Hugh J. Fraser,* vice president in general charge of all plant operations in the United States of The International Nickel Co., Inc., has been announced.

Norton Co. has announced the death of its vice president, *Wallace Tenney Montague.*

Alsop Engineering Corp. has announced the death of its vice president, *James J. O'Shea* after a brief illness.

Lammont du Pont, former president of E. I. du Pont de Nemours & Co. and youngest of the three brothers who led the 20th century development of the company, died at the age of 71.

Jacoby-Carbox Corp. has announced the death of *Henry E. Jacoby.*

News of Companies

1952 marks the 27th anniversary year of *St. John X-Ray Laboratory* as pioneers in the field of industrial radiology.

SIPI Metals Corp. is the new name for *Silverstein & Pinsof, Inc.,* well-known Chicago smelters and refiners.

The opening of a mid-west office in St. Louis by *Arthur D. Little, Inc.* has been announced.

The establishment of the *Ramset Div.,*

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SLEEVE BEARING DATA

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SLEEVE BEARING DATA

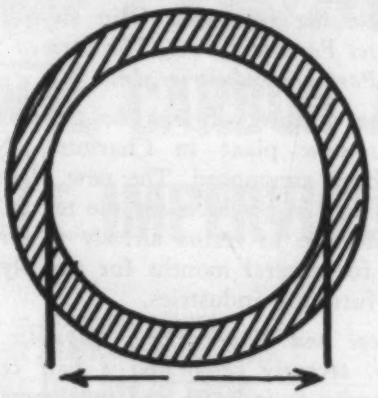
Stock Sizes or Specials?

THE trend, in recent years, among leading designers of machinery and equipment is to use standard stock parts rather than specials wherever possible. And there is sound reasoning behind this move, particularly in cast bronze sleeve bearings.

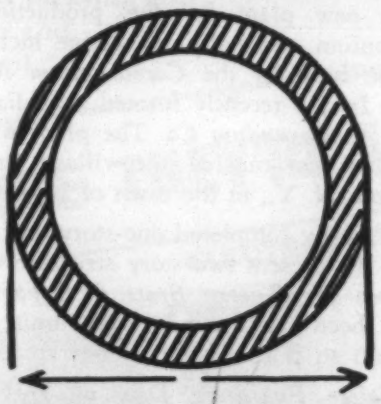
Naturally in some instances it is essential to design and produce a special bearing for a specific application. Such factors as flanges, wall thickness, taper, special alloys and other characteristics that cannot be provided for in stock bearings can only be secured through special manufacturing operations. This often necessitates special patterns, tools, dies or other equipment not included in the cost of stock items. With the exception of long production runs of one size, special bearings are more costly than stock items.

The factors that favor the designer in working to standard stock bearings are many. First, he has an unusually large range of sizes from which to make his choice. At the present we list over 850, comprised of 55 inside diameters, ranging from $\frac{1}{4}$ inch to $4\frac{1}{4}$; 55 outside diameters $\frac{3}{8}$ to $4\frac{1}{2}$; 46 lengths ranging from $\frac{3}{4}$ to $9\frac{3}{4}$. Thus it is possible to secure practically any size combination desired.

Standard stock bearings are cast in what is usually referred to as a general purpose alloy, providing better than average physical properties assuring long life and excellent performance. Oil grooves, slots, or holes are easily, quickly and economically added. Standard tolerances, as listed below, can easily be altered where closer precision is required or where greater clearance is necessary.



55 Inside Diameters



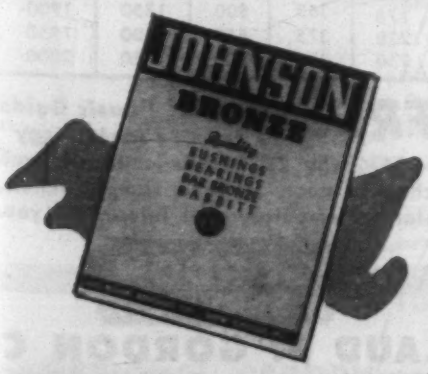
55 Outside Diameters

46 Lengths

Stock bearings are lower in cost, too, a very important feature in today's market. By making long runs of each size we are able to secure a low unit cost, which saving is passed on to the user. There is never any charge for patterns or tools. Complete stocks of all sizes are always maintained providing immediate delivery in any quantity. This eliminates the necessity for maintaining extensive inventory yet provides immediate service.

Engineering Service

It has always been the policy of the Johnson Bronze Company to work with customers in order to give them the greatest value for their money when purchasing bearings. In many cases we have found that a very slight change in bearing specifications or a slight alteration of a stock bearing will give the user the full benefits of this stock bearing service. We can also help you determine the correct type of bearing for each application. As we manufacture all types of Sleeve Bearings, we base all of our recommendations on facts, free from prejudice. Why not take full advantage of this free service?



CATALOGUE —*Lists and describes the most complete stock bronze sleeve bearing service on the market. Its more than 80 pages are filled with helpful bearing data. Write for free copy.*

Tolerances

Years of constant study of the bearing requirements of machinery builders have not only guided the selection of the sizes to stock as standard but have also governed the decision on the proper tolerances to standardize on. We find the following most acceptable:

Outside Diam. up to 3"....plus .002" to .003"

Outside Diam. above 3"...plus .003" to .005"

All Inside Diameters.....plus or minus .001"

All Lengths.....plus or minus .005"

This bearing data sheet is but one of a series You can get the complete set by writing to—

Johnson Bronze

SLEEVE BEARING HEADQUARTERS
769 S. MILL ST. • NEW CASTLE, PENNA.

NOW you can

BRIGHT-ANNEAL STAINLESS

on a continuous production basis, with

The

SARGEANT & WILBUR

Controlled Atmosphere

CONVEYOR FURNACE

PARTS MADE OF STAINLESS can be

BRIGHT-ANNEALED,

BRIGHT-HARDENED, or

BRIGHT-BRAZED without oxidation . . . they come out scale-free, bright, and clean. No pickling required, no tumbling, no sand blasting.

With our special S. & W. alloy for bright-brazing stainless, the color matches the metal; resists dulling; and the joint is practically invisible. *Gold and silver parts are soldered* in the same continuous-production furnace with equal success.

Your samples processed free. If you want to see some of your own work bright-annealed, bright-hardened, or bright-brazed in a *conveyor furnace*, send us samples and specifications.

SARGEANT & WILBUR, INC.
180 Weeden St.
PAWTUCKET, R. I.

Send your illustrated folder "How to BRIGHT-ANNEAL STAINLESS in the S. & W. Conveyor Furnace."

Name .....

Company .....

Address .....

Representatives:
NEW YORK CITY and PENNSYLVANIA Gerald B Duff, 68 Clinton Ave., Newark, N. J.; MICHIGAN and NORTHERN OHIO M. C. Schwer, 2970 W. Grand Blvd., Detroit 2, Mich.; NEW ENGLAND James J. Herkis, 180 Weeden St., Pawtucket, R. I.

News Digest

as the ninth operating division of *Olin Industries, Inc.*, and the appointment of J. E. Williams as general manager have been announced. The division will be responsible for the development, production and sale of power-actuated tools, fastening studs and accessories, and will operate the following Olin subsidiaries: *Ramset Fasteners, Inc., The Stemco Corp.* and *Portable Industries, Inc.*

The opening of *Reichhold Chemicals, Inc.'s* new plant in Charlotte, N. C. has been announced. The new plant will specialize in products for the textile field, in addition to resins already in production for several months for the plywood and furniture industries.

Steel and Tubes Div., Republic Steel Corp. recently celebrated a half century of service to industry and consumers with informal 50th Anniversary ceremonies.

A new plant for the production of zirconium and hafnium sponge metals is to be built by the *Carborundum Metals Co., Inc.*, a recently formed subsidiary of *The Carborundum Co.* The plant will be located just outside the village line of Akron, N. Y., in the town of Newstead.

A newly completed one-story unit abutting the present two-story structure which houses the *Eastern Brass & Copper Co.* has been announced. The unit adds 17,000 sq ft to Eastern's floor space.

Kaiser Engineers Div. of *Henry J. Kaiser Co.* announced the establishment of headquarters at Richland, Wash., to initiate work on a major construction contract involving expansion of the Hanford operations of the Atomic Energy Commission.

According to a recent announcement, *Aluminum Co. of America* will undertake the construction of a 400-million dollar aluminum smelting project in Alaska as soon as the necessary land can be purchased and government approvals obtained.

The Raytheon Manufacturing Co. officially opened its new office building at 3076 W. 117th St., Waltham, Mass.

Blaw-Knox Co. has begun construction work on a large and modern lithium processing plant at Sunbright, Va., This project is being executed for the *Foote Mineral Co.*, pioneers in lithium production.

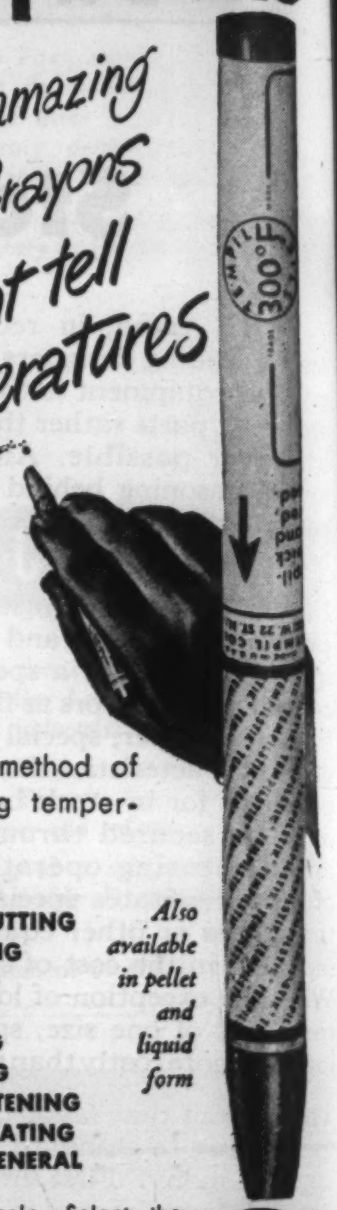
Formal dedication ceremonies were recently held for *Modern Steel Treating Co.'s* new 60,000 sq-ft plant located in Chicago. The opening was attended by persons prominent in metal working throughout the nation.

Hagan Corp., combustion and chemical engineering firm, has purchased *American Cast Products, Inc.*, Orrville, Ohio.

M. E. Cunningham Co., manufacturers of Mecco safety steel stamps, dies and other marking tools, has acquired a new

Tempilstiks°

the amazing Crayons that tell temperatures



A simple method of controlling temperatures in:

- WELDING
- FLAME-CUTTING
- TEMPERING
- FORGING
- CASTING
- MOLDING
- DRAWING
- STRAIGHTENING
- HEAT-TREATING IN GENERAL

Also available in pellet and liquid form

It's this simple: Select the Tempilstik° for the working temperature you want. Mark your workpiece with it. When the Tempilstik° mark melts, the specified temperature has been reached.

$2 each

gives up to 2000 readings

Available in these temperatures (°F)

113	263	400	950	1500
125	275	450	1000	1550
138	288	500	1050	1600
150	300	550	1100	1650
163	313	600	1150	1700
175	325	650	1200	1750
188	338	700	1250	1800
200	350	750	1300	1850
213	363	800	1350	1900
225	375	850	1400	1950
238	388	900	1450	2000
250				

FREE —Tempil° "Basic Guide to Ferrous Metallurgy" — 16¼" by 21" plastic-laminated wall chart in color. Send for sample pellets, stating temperature of interest to you.

GORDON SERVICE

CLAUD S. GORDON CO.

Manufacturers & Distributors

Thermocouple Supplies • Industrial Furnaces & Ovens
Pyrometers & Controls • Metallurgical Testing Machines
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Banish the "Bite"

ON PICKLING AND PLATING EQUIPMENT

with these NATIONAL CARBON AND GRAPHITE AND KARBATE IMPERVIOUS GRAPHITE PRODUCTS

TRADE-MARK

BRAND

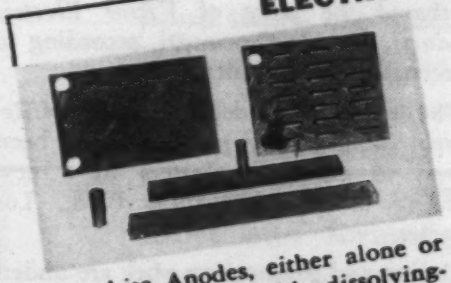
Pickling and tinning are messy, expensive — and *necessary*. However, you can *greatly reduce* equipment maintenance costs and improve plant housekeeping by making full use of these National Carbon products wherever service is dirty and tough. As is well known by manufacturers of your pickling and plating *solutions*, only carbon and graphite and impervious graphite withstand the "bite" of so wide a range of corrosive chemicals.

HERE'S WHERE THEY'RE USED:

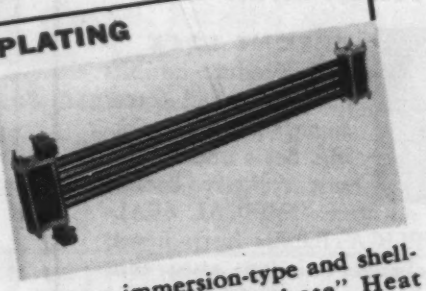
STAINLESS PICKLING

Carbon brick tank linings with "Karbate" Plate-Type Heat Exchangers and drain lines offer powerful resistance to nitric-hydrofluoric solutions.

ELECTROLYTIC PLATING

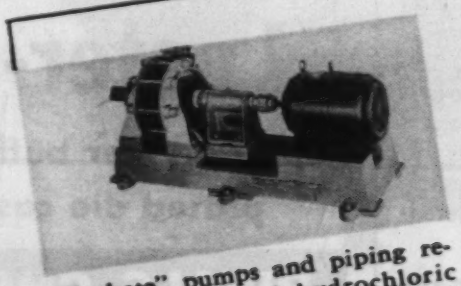


Graphite Anodes, either alone or in combination with dissolving-type anodes, are non-contaminating and long lasting.



Various immersion-type and shell-and-tube type "Karbate" Heat Exchangers are available to suit capacity requirements.

CARBON STEEL PICKLING



"Karbate" pumps and piping resist sulphuric and hydrochloric acid attack . . . protect solution from contamination.

"Karbate" Shell-and-Tube Heat Exchangers are often most economical where more than 50 square feet of heat transfer surface is required.

Graphite Tank Rolls provide an ideal combination of good electrical conductivity and resistance to acid attack in electrolytic pickling operations.

The terms "Karbate" and "National" are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY

A Division of Union Carbide and Carbon Corporation

30 East 42nd Street, New York 17, New York

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

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WRITE FOR CATALOG SECTION—S-5005

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BLAST FURNACE LININGS • BRICK • CINDER NOTCH LINERS • CINDER NOTCH PLUGS • SKIMMER BLOCKS • SPLASH PLATES • RUNOUT TROUGH LINERS • MOLD PLUGS • TANK HEATERS

PRC tapes feature natural anti-deterioration and rattle cushioning values. Special impregnations also provide unmatched *protective sealing* characteristics. FOR EXAMPLE:

CHROME LOCK
This product inhibits electrolysis and corrosion. Is also anti-wicking. Seals under pressure. Adhesive back is pressure sensitive. TYPICAL SEALING APPLICATIONS: Instruments; glazing channel window sash; skin laps on bus bodies; weatherseal for trailercoaches.

KLING FELT

Features a new, solvent-activated adhesive (one side only) that sticks to all surfaces. Can be applied to cold metal. WON'T PULL LOOSE!

TYPICAL APPLICATIONS: Weather Strip for windows, doors, etc.; dust and moisture seal for electric control panels; rattle cushioner.

PRE-SEGMENTED
PRC tapes can be supplied in segmented rolls according to order. Each segment is pre-cut to a sufficient depth to permit easy detaching. Ideal for volume application of equal-size pieces.

Write for free test sample and new engineering folder—TF-210

PRC

PRODUCTS RESEARCH CO.
3126 LOS FELIZ BLVD., LOS ANGELES 39, CALIF.
Representatives in All Principal Cities

News Digest

plant in Pittsburgh which will more than double working space.

Reflin Co., manufacturers of Fiberglas-reinforced tubing, have doubled production capacity by moving to a new plant at 16825 S. Broadway, Gardena, Calif.

Battelle Memorial Institute recently broke ground for a new million-dollar special purpose laboratory building. Construction was authorized by the National Production Authority because of the important defense research being conducted at the Institute.

Ferro Corp. has recently expanded its operations and has taken over *Wel Met Co.* of Kent, Ohio. They are also entering the glass fiber field with a plant in Nashville, Tenn.

A million-dollar porcelain enameling plant, which will produce porcelain-on-steel interiors for refrigerators and other parts, will be opened soon by the *Coolerator Co.*, an associate of the International Telephone and Telegraph Co. All the enameling equipment, including the huge baffle furnace, dryers and sprayers are being provided by the *Ferro Corp.* of Cleveland.

Allis-Chalmers Manufacturing Co. has purchased the plant of *Victor Electric Products, Inc.*, in Cincinnati, according to a recent announcement.

The engineering department of *AiResearch Manufacturing Co.* has been moved to enlarged quarters in a new building at 9225 Aviation Blvd., Los Angeles.

Design and engineering work are underway and Certificates of Necessity have been issued by the Defense Production Administration for a new plant in Los Angeles County for *Carbide and Carbon Chemicals Co.* Here the company plans to produce polyethylene and ethylene glycol.

The Port Neches, Tex, GR-S synthetic rubber plant operated by *Naugatuck Chemical Div., U. S. Rubber Co.*, is being converted from "hot" to "cold" synthetic rubber and its production capacity increased from 70,000 long tons to more than 100,000 long tons annually. The program is expected to be completed by late fall.

Norton Co.'s new grinding machine expansion in Worcester, Mass., is nearing completion and is expected to be in full operation this fall or early winter.

Construction of *General Refractories Co.'s* new one-million dollar plant in Los Angeles for the manufacture of unburned basic brick is now completed and in full operation, according to a recent announcement.

Dial Screw Products Co., Inc. has completed a new plant at 126-02 Northern Blvd., Corona, N. Y.

American Can Co.'s new multi-million

Luster-on®
is the ideal "PAINT BOND" for your
ZINC DIE-CASTINGS

Applied in one quick dip
Manually or Automatically
Most uniform results
Most easily controlled
Lowest possible cost

Luster-on®
may be left as a final
COLORED FINISH
with excellent corrosion protection

Luster-on®
applied over buffed, zinc-plated die castings
RIVALS CHROME
Write for free data sheets

THE *Chemical* CORPORATION
67 Waltham Avenue, Springfield 9, Mass.

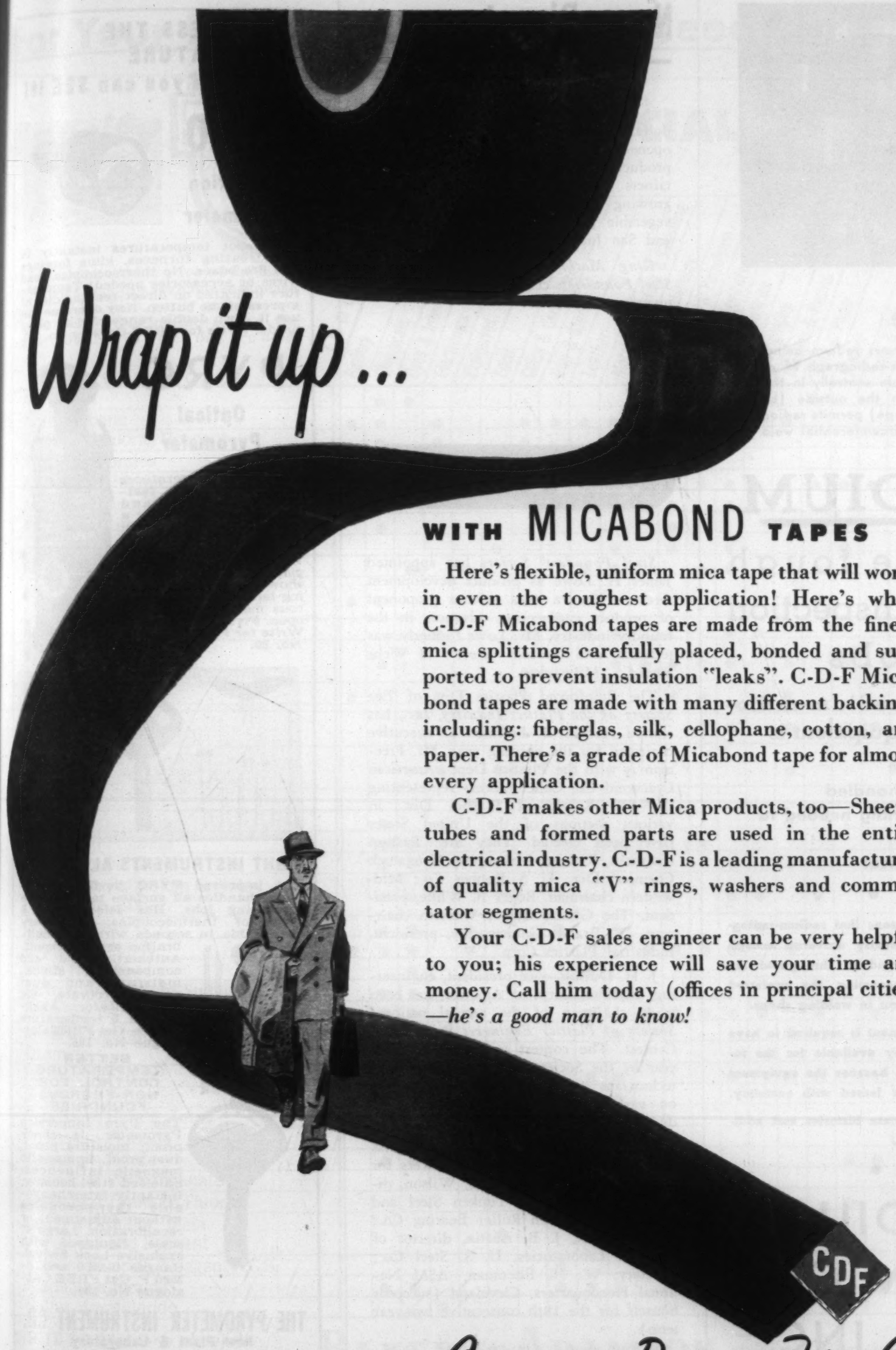
Wrap it up...

WITH MICABOND TAPES

Here's flexible, uniform mica tape that will work in even the toughest application! Here's why: C-D-F Micabond tapes are made from the finest mica splittings carefully placed, bonded and supported to prevent insulation "leaks". C-D-F Micabond tapes are made with many different backings including: fiberglas, silk, cellophane, cotton, and paper. There's a grade of Micabond tape for almost every application.

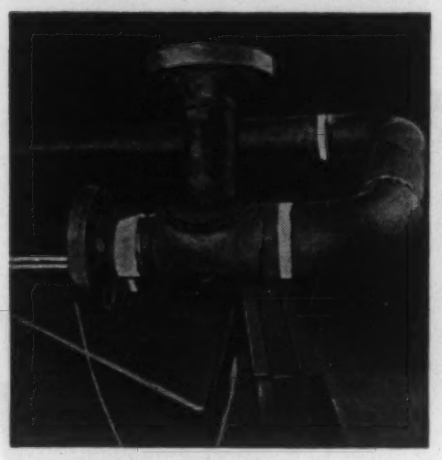
C-D-F makes other Mica products, too—Sheets, tubes and formed parts are used in the entire electrical industry. C-D-F is a leading manufacturer of quality mica "V" rings, washers and commutator segments.

Your C-D-F sales engineer can be very helpful to you; his experience will save your time and money. Call him today (offices in principal cities) *—he's a good man to know!*



Continental-Diamond Fibre Company

GENERAL OFFICES:
NEWARK 25, DELAWARE



Use

THIS PHOTO shows radium being used to take a radium-radiograph of a weld. Placing the radium centrally in the pipe and the film on the outside (held in place by white tape) permits radiographing the entire circumferential weld with one exposure.

RADIUM

for the tough weld inspection jobs

because radium-radiographing equipment is

1. Portable
2. Easily handled
3. No training needed to operate
4. Economical

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For the same reasons that radium-radiography has won nearly universal acceptance in steel foundries throughout the country, it is becoming the preferred means of inspection in welding shops.

No capital investment is required to have radium-radiography available for the inspection of welds because the equipment may be rented or leased with economy.

Write today for case histories and additional information.

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RADIUM CHEMICAL CO., INC.

161 East 42 Street, New York 17, N. Y.
Marshall Field Annex Bldg., Chicago, Ill.
3723 Wilshire Blvd., Los Angeles 5, Cal.

News Digest

dollar Stockton, Calif. plant was officially opened recently. The plant, with a rated production capacity of 350,000,000 containers a year, was built to meet the growing demands of the vital fruit and vegetable packing industry of the Delta and San Joaquin Valley.

King Machine Tool Div., American Steel Foundries, celebrates its Golden Anniversary this year.

News of Societies

Steel Founders' Society has appointed James H. Lowe as product development director. Known as a veteran proponent of product engineering advances in the foundry industry, Mr. Lowe formerly was technical and research director of Wehr Steel Co., Milwaukee.

The Reinforced Plastics Div. of *The Society of the Plastics Industry, Inc.,* has elected Harold B. Freeman as executive chairman for the ensuing year. Mr. Freeman is with the Plastics Dept., American Cyanamid Co. Other officers representing the SPI Reinforced Plastics Div. in various sections of the United States have been elected. They are: Eastern chairman, Richard Malamphy, Naugatuck Chemical Div., U. S. Rubber Co.; Midwestern chairman, Roger B. White, president, The Glastic Corp.; Western chairman, W. Brandt Goldsworthy, president, Industrial Plastics Corp.

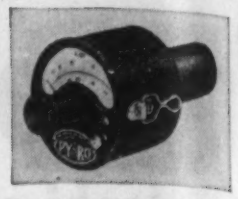
J. H. DuBois, vice president, engineering, Mycalex Corp. of America, has been made chairman of the annual national *Society of Plastics Engineers* Prize Paper Contest. The contest in sponsored each year by the Society to encourage plastics technicians to prepare technical papers on various phases of the plastics industry.

The American Society for Metals has announced the following new officers for 1952-53: president, Ralph L. Wilson, director of metallurgy, Timken Steel and Tube Div., Timken Roller Bearing Co.; vice president, J. B. Austin, director of Research Laboratories, U. S. Steel Co.; secretary, W. H. Eisenman, ASM National Headquarters, Cleveland (succeeds himself for the 18th consecutive two-year term).

The International Tin Research and Development Council, has announced that it will be known in the future as *The International Tin Research Council.* This change will not affect the policy of the

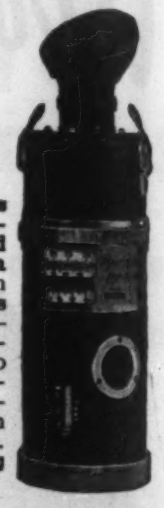
WHY GUESS THE TEMPERATURE
. . . When you can SEE it!

PYRO
Radiation
Pyrometer

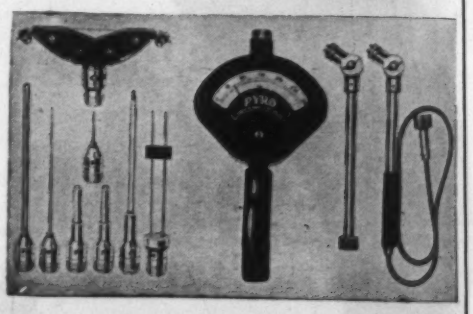


Tells spot temperatures instantly in heat-treating furnaces, kilns forgings and fire boxes. No thermocouples, lead wires or accessories needed! Temperature indicated on direct-reading dial at a press of the button. Any operator can use it. Two double-ranges for all plant needs. Write for FREE Catalog No. 100.

PYRO
Optical
Pyrometer

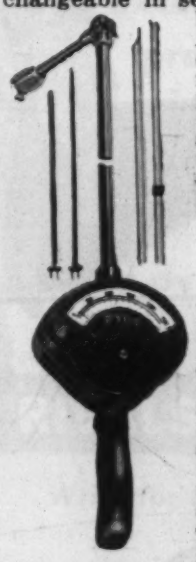


Determines temperatures of minute spots, fast-moving objects and smallest streams — at a glance! No correction charts or accessories needed. Easy to use—weighs only 3 lbs. Special types available to show true spout and pouring temps. of molten ferrous metal measured in open. Five temp. ranges. Write for FREE Catalog No. 80.



EIGHT INSTRUMENTS ALL IN ONE

The improved PYRO Surface Pyrometer handles all surface temperature measuring jobs. Has selection of 8 types of thermocouples; all interchangeable in seconds with no recalibration or adjustment. Automatic cold end compensator, shock, moisture and dust proof. Accurate, big 4¾" indicator. Available in 5 temperature ranges. Get FREE Catalogue No. 165.



BETTER TEMPERATURE CONTROL FOR NON-FERROUS FOUNDRIES

The Pyro Immersion Pyrometer is shock proof, moisture proof, dust proof, immune to magnetic influences. Shielded steel housing. Instantly interchangeable thermocouples without adjustment or recalibration. Large 4" scale. Equipped with exclusive Lock Swivel. Ranges 0-1500 and 0-2500 F. Get FREE Catalogue No. 150.

THE PYROMETER INSTRUMENT CO.
New Plant & Laboratory
BERGENFIELD 27, NEW JERSEY

Manufacturers of Pyro Optical, Radiation Immersion and Surface Pyrometers for over 25 years.

For Your High-Purity Process Needs···

Specify B&A FINE and SPECIAL CHEMICALS

The following are but a few of the many B&A Fine Chemicals available in tonnage quantities for high purity process use. They are charted to indicate some of the major industries in which they are used.

CHEMICAL	Battery	Chemicals	Dyes & Intermediates	Electronics	Explosives	Food	Glass & Ceramics	Iron & Steel	Leather	Metal Fabricating & Finishing	Mining & Metallurgy	Oil Refining & Petroleum	Paints & Pigments	Pharmaceuticals	Photography	Plastics & Resins	Pulp & Paper	Rubber	Soap & Detergents	Textiles	Water Treatment
Acetamide		●	●										●			●					
Acid Fluoboric	●	●		●			●	●	●	●	●	●			●						
Acid Hydrofluoric, Reagent		●		●			●			●	●										
Alkali Fluoborates							●	●		●	●										
Aluminum Chloride, Solution		●	●			●	●		●	●	●	●	●	●		●	●	●	●	●	
Aluminum Fluoride, Crystal		●								●	●		●								
Aluminum Nitrate		●		●							●								●		
Ammonium Acetate						●				●	●		●				●		●		
Ammonium Oxalate			●		●				●	●		●	●			●	●		●		
Ammonium Sulfate Purified and Reagent A.C.S.	●	●				●	●		●	●			●		●	●			●		
Ammonium Thiosulfate				●					●	●			●	●					●		
Boron Trifluoride Gas and Various Complexes		●								●	●	●	●		●		●		●		
Cadmium Nitrate	●	●		●			●					●	●		●						
Calcium Acetate Purified and Reagent		●				●						●	●		●		●	●			
Calcium Chloride, Anhydrous Purified and Reagent A.C.S.				●		●									●						
Calcium Phosphide					●						●										
Chlorine Trifluoride		●													●						
Chromium Fluoride		●	●							●		●							●		
Chromium Nitrate		●													●						
Chromium Potassium Sulfate (Chrome Alum)		●	●					●					●	●		●			●		
Cupric Nitrate		●	●		●			●		●				●					●		
Cuprous Chloride	●	●	●		●						●	●	●	●	●				●		
Ferric Nitrate			●					●											●		
Ferrous Ammonium Sulfate		●	●							●							●				
Lead Nitrate		●	●		●				●		●	●	●	●	●	●		●	●		
Metal Fluoborates										●					●						
Oxamide					●																
Potassium Acetate		●		●					●	●			●		●	●				●	
Potassium Bifluoride		●		●			●			●										●	
Potassium Borate, Tetra										●											
Potassium Fluoride		●								●											
Potassium Nitrite		●	●			●				●		●						●	●		
Potassium Permanganate																					●
Potassium Titanium Fluoride											●										
Sodium Bisulfite, Meta Purified and Reagent						●								●						●	
Sodium Fluoride, Reagent A.C.S.								●					●								
Stannous Chloride		●	●					●	●	●			●					●	●		
Sulfur Hexafluoride				●																	

WRITE TODAY for a complete listing of B&A Fine Chemicals.

BAKER & ADAMSON *Fine Chemicals*

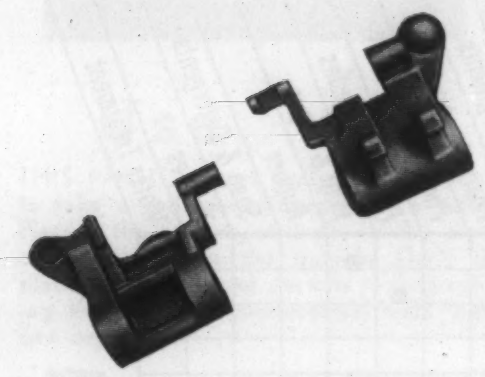
GENERAL CHEMICAL DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 RECTOR STREET, NEW YORK 6, N. Y.

SETTING THE PACE IN CHEMICAL PURITY SINCE 1882

functional design made possible



Two views were necessary to show the complex outline of the above illustrated piece. This was designed specifically to be made as a Precision Investment Casting with the thought in mind of making it light, compact, strong and completely functional. It is cast in SAE-1020 steel complete except for reaming the hole, and the drilling and tapping two small holes in the body.

Permit us to show you how your product might be produced better and more economically by Precision Investment Casting.

GRAY-SYRACUSE INC.

107 N. Franklin Street, Syracuse 4, N. Y.

Small precision castings of ferrous and non-ferrous alloys.

Gray-Syracuse, Inc.
107 N. Franklin Street
Syracuse 4, N. Y., Dept. "A"

Please send me literature on Precision Investment Castings.

NAME .....
COMPANY .....
ADDRESS .....
CITY .....ZONE...STATE.....

News Digest

Council nor alter its current activities.

The American Welding Society has selected the winners of the 1951-52 A. F. Davis Undergraduate Welding Awards, which include cash prizes of $700 and award certificates. Two Cornell University undergraduate engineers, Paul J. Wisniewski and David A. Thomas, won first prize of $200 with their paper entitled "Metal Transfer in Arc Welding", which appeared in the April 1952 issue of *The Cornell Engineer*. *The Cornell Engineer* will also receive a $200 cash prize for publishing the winning paper. A Wisconsin senior, Norman Fletcher, has been selected as winner of the second prize. His paper, on the subject of "Arc Welded Machine Jigs", was published in the November 1951 issue of *The Wisconsin Engineer*. Mr. Fletcher and the publication will each receive $150 for second prize.

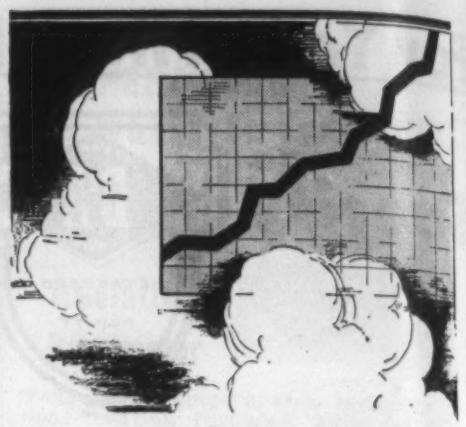
Armour Research Foundation of *Illinois Institute of Technology* recently sponsored a Centennial Conference on Industrial Research during the Centennial of Engineering. Some 300 research executives from industries throughout the country attended the conference held on the Illinois Tech campus.

L. F. Hickernell, chief engineer of the Anaconda Wire & Cable Co., has been named chairman of the newly formed Committee on Technical Operations of the *American Institute of Electrical Engineers*. The new committee will be coordinating agency for the AIEE's five technical divisions, which represent 38 technical committees; and will supervise all technical affairs of the Institute.

A new competition for designers, engineers and manufacturers of machinery of all types has just been announced by *The James F. Lincoln Arc Welding Foundation*. The new $30,000 Mechanical Design Award Program offers $30,000 in 101 cash awards, as well as national recognition, for the best papers describing the mechanical design and construction of any type of machine or machine component which is designed for arc welded steel fabrication.

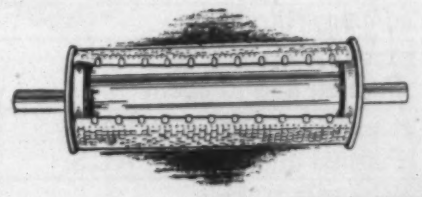
American Society of Tool Engineers has announced the appointment of John W. Greve as editor of *The Tool Engineer*, the official publication of the Society.

The University of Michigan, Dept. of Chemistry has announced a graduate fellowship in electrochemistry to promote fundamental research in that field and train more electrochemists for key industrial positions. Established by General Motors and approved by the University's Board of Regents, the fellowship provides a cash award of $1800 to the fellowship holder and $1000 to the University to cover tuition, special apparatus and other costs. It will be offered during 1952-53 and will be subject to renewal from year to year.



WORRIED about SKY-HIGH COSTS?

A maker of fixtures for heat-treating small parts found that by using stainless tubing Type 304, the average "life" of his device rose from a few runs to over 500, at an operating temperature of 1450° F. for a one-hour run. Savings ran to $1,500 a month.



True, stainless is higher priced than other metals, but—in the long run—it does a better job at lower overall cost.

If your design requires strength and lightness, consider Murray tubing. Immediately available from warehouse in a wide range of sizes and analyses.

Other Murray products include carbon steel tubing and pipe for mechanical and pressure purposes; Welding and screw type pipe and tube fittings. Tube bending, upsetting, swaging.

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A B MURRAY CO INC
ESTABLISHED 1845
ELIZABETH, N. J. McKEESPORT, PA.

PLASTICS

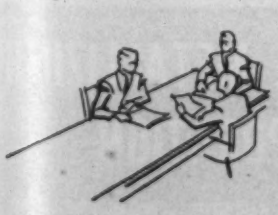
add sales appeal!

protective, transparent, selling . . .

packages made of STYRON

During October, which is National Dairy Month, as well as all year around, much interest is centered on the dairy industry. Its high-geared promotions have stressed better packaging and the utmost in protection. Styron packages, for example, have been used not only to give outstanding protection but to add sales appeal on retail counters. These packages are self-selling salesmen with unusual clarity, eye-appeal and buy-appeal. In the dairy field, moisture resistance of Styron keeps cheese fresh and flavorful—and affords lasting protection.

Let these packaging advantages be yours today. Why not *work together* with experts from Dow's Plastics Technical Service and an experienced molder to give *your* packages harder sell at the point-of-sale?



let's work it out together!

Write Today

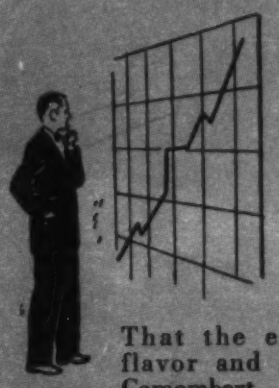
THE DOW CHEMICAL COMPANY

Plastics Department—PL 442D

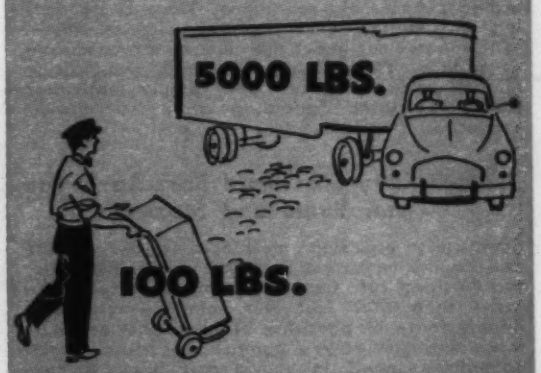
MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Atlanta
Cleveland • Detroit • Chicago • St. Louis
Houston • San Francisco • Los Angeles • Seattle
Dow Chemical of Canada, Limited, Toronto, Canada

DID *you know?*



That the epicurean flavor and aroma of Camembert cheese is caused by the presence of the blue mold *penicillium camemberti?* When a cheese manufacturer protected the soft delicacy of Camembert cheese with gleaming, rigid polystyrene packaging—*at a price nearly 10% higher*—sales skyrocketed over six times. Once reserved for the gourmet, over 30,000,000 wedges of Camembert cheese were devoured in the U. S. last year!



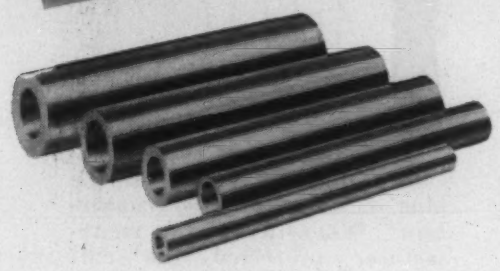
When mass production molding methods were first introduced to the plastics industry, a machine could produce a three-ounce finished part . . . or 100 pounds of products per day. A recently developed machine can consume up to 300 ounces of polystyrene at once . . . or mold 5,000 pounds of finished parts per day. In less than two decades, a machine capacity increase of 4900%.

DOW
plastics

Promet Bars Stand Up Where the Going Is Tough!

PROMET
THE Engineered BRONZE

CORED & SOLID BRONZE BAR STOCK



Made from Promet No. 6, an outstanding leaded bearing bronze noted for its free machining properties. Unbelievably great resistance to heat and wear. Will not burn, seize, pound out.

Promet's High Safety Factor is Your Insurance Against Bearing Failure!

Tougher, harder and stronger, it resists shock loads and withstands high compressive forces and will not cut, or stick to the shaft under ordinary operating conditions. There is no seizing, no scoring—just smooth, quiet operation. Will not powder under the most severe conditions or service. When lubrication fails temporarily, Promet carries on safely until proper lubrication can be restored, affording protection against production shutdowns.

Promet Fully Machined Bars Save You Time, Tools and Money!

Completely precision machined inside, outside and on the ends, yet sufficient stock remains for the finishing cut. Can be machined at speeds of more than 500 feet per minute—more than double those of phosphor bronzes. This complete machining insures you against subsurface defects sometimes found in rough cast bars. A considerable amount of metal has already been removed—metal which you would be purchasing if you used rough bars. Every bar is absolutely concentric.

Available round, hexagon and square, in 13-inch lengths, rough cast.

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of longer, superior service and lower maintenance cost.

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Our competent design and engineering staff will be glad to assist you in solving your special bearing problems.

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Please send free literature on Promet Cored and Solid Bronze Bar Stock.

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Meetings and Expositions

GRAY IRON FOUNDERS' SOCIETY, annual meeting. Cleveland. Oct. 16-17, 1952.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Institute of Metals Div. fall meeting. Philadelphia. Oct. 20-22, 1952.

AMERICAN SOCIETY FOR METALS, annual meeting. Philadelphia. Oct. 20-24, 1952.

AMERICAN WELDING SOCIETY, annual meeting. Philadelphia. Oct. 20-24, 1952.

NATIONAL METAL CONGRESS & EXPOSITION. Philadelphia. Oct. 20-24, 1952.

SOCIETY FOR NON-DESTRUCTIVE TESTING, annual meeting. Philadelphia. Oct. 22-23, 1952.

PORCELAIN ENAMEL INSTITUTE, annual meeting. White Sulphur Springs, W. Va. Oct. 22-24, 1952.

SOCIETY OF AUTOMOTIVE ENGINEERS, transportation meeting. Pittsburgh. Oct. 22-24, 1952.

ELECTROCHEMICAL SOCIETY, fall meeting. Montreal. Oct. 26-30, 1952.

AMERICAN GAS ASSOCIATION, annual convention. Atlantic City, N. J. Oct. 27-30, 1952.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, annual machine tool conference. Albany. Oct. 29-31, 1952.

AMERICAN SOCIETY OF BODY ENGINEERS, annual convention. Detroit. Oct. 29-31, 1952.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Fuels and AIME Coal Divs. joint conference. Philadelphia. Oct. 30-31, 1952.

SOCIETY OF AUTOMOTIVE ENGINEERS, diesel engine meeting. St. Louis. Nov. 3-4, 1952.

PITTSBURGH DIFFRACTION CONFERENCE. Pittsburgh. Nov. 6-7, 1952.

SOCIETY OF AUTOMOTIVE ENGINEERS, fuels and lubricants meeting. Tulsa. Nov. 6-7, 1952.

NATIONAL FOUNDRY ASSOCIATION, annual meeting. Chicago. Nov. 10-12, 1952.

AMERICAN STANDARDS ASSOCIATION, annual meeting. New York. Nov. 19, 1952.

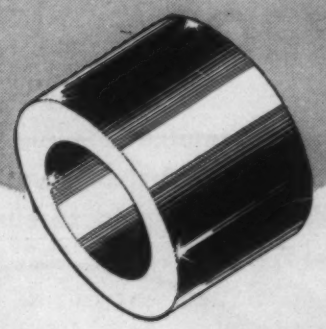
AMERICAN SOCIETY FOR QUALITY CONTROL, Mid-West Conference. Indianapolis. Nov. 20-21, 1952.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, annual meeting. New York. Nov. 30-Dec. 5, 1952.

NATIONAL POWER SHOW. New York. Dec. 1-6, 1952.

GRAPHALLOY
TRADE MARK REG. U. S. PAT. OFF.

OIL-FREE
SELF-LUBRICATING
BUSHINGS



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Widely Used Where Ordinary Oil Lubrication Is Impractical or Impossible.

EXCELLENT DURABILITY • CONSTANT CO-EFFICIENT OF FRICTION • APPLICABLE OVER A WIDE TEMPERATURE RANGE — EVEN WHERE OIL SOLIDIFIES OR CARBONIZES • OPERATE DRY, OR AT HIGH SPEEDS SUBMERGED IN WATER, GASOLINE AND OTHER LIQUIDS • EXCELLENT FOR CURRENT-CARRYING BEARINGS

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